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LEO C. MASSOPUST, Editor
Marquette University, School of Medicine
Milwaukee, Wisconsin

ASSOCIATE EDITORS

ANNE SHIRAS
School of Medicine
University of Pittsburgh, Pa.

ARTHUR W. PROETZ, M.D.
Beaumont Building
St. Louis, Mo.

FERDINAND HARDING
The Children's Hospital
Boston, Mass.

ARTHUR W. FUCHS
345 State St.,
Rochester, N. Y.

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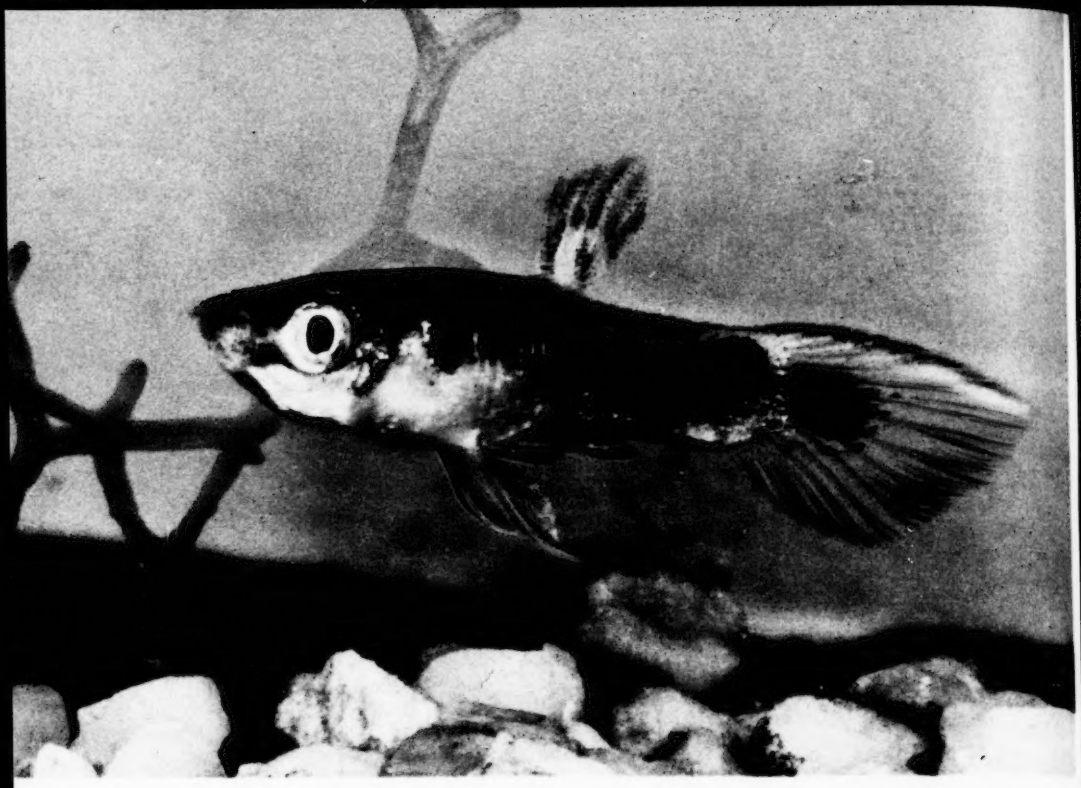

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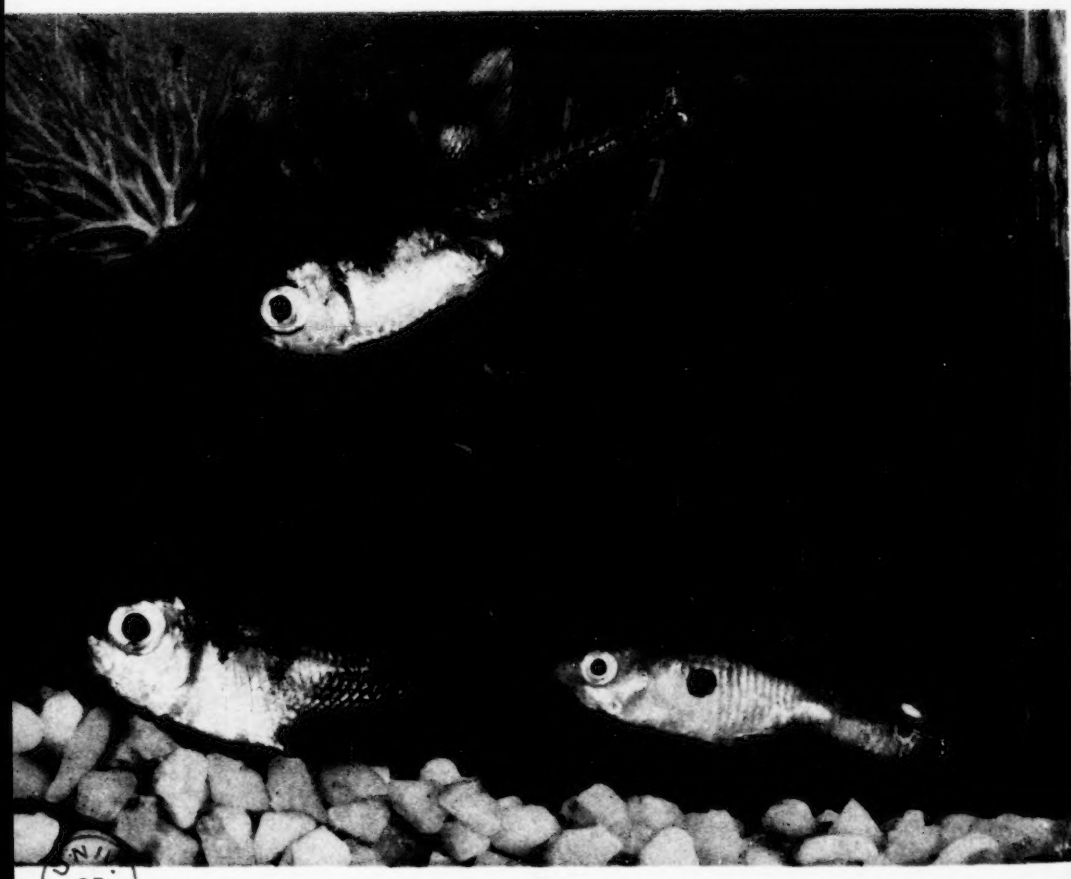

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PHOTOGRAPHING SMALL LIVE FISH IN FULL COLOR

H. L. GIBSON*

THIS problem is not as simple as making the standard red herring and newspaper set-up so beloved by still-life artists of the garret school. There are several obstacles in the path; however, they are easy to overcome so that no special difficulty should be encountered by any enthusiastic scientific photographer. The following paper describes a method used in taking Kodachrome Color Film pictures of Bantam camera size at magnifications of 1⅓ or less. The first subject was a tiny guppy, *Lebistes reticulatus*, ¾-inch long. The photographic equipment comprised a Kodak Recomar No. 33 and a Miniature Kodachrome Adapter.

In order to confine the mean free path of the fish to roughly the field of view

* Received for publication July 5, 1939. Service Department of Eastman Kodak Company, Rochester, N. Y.

List of Captions for Figures

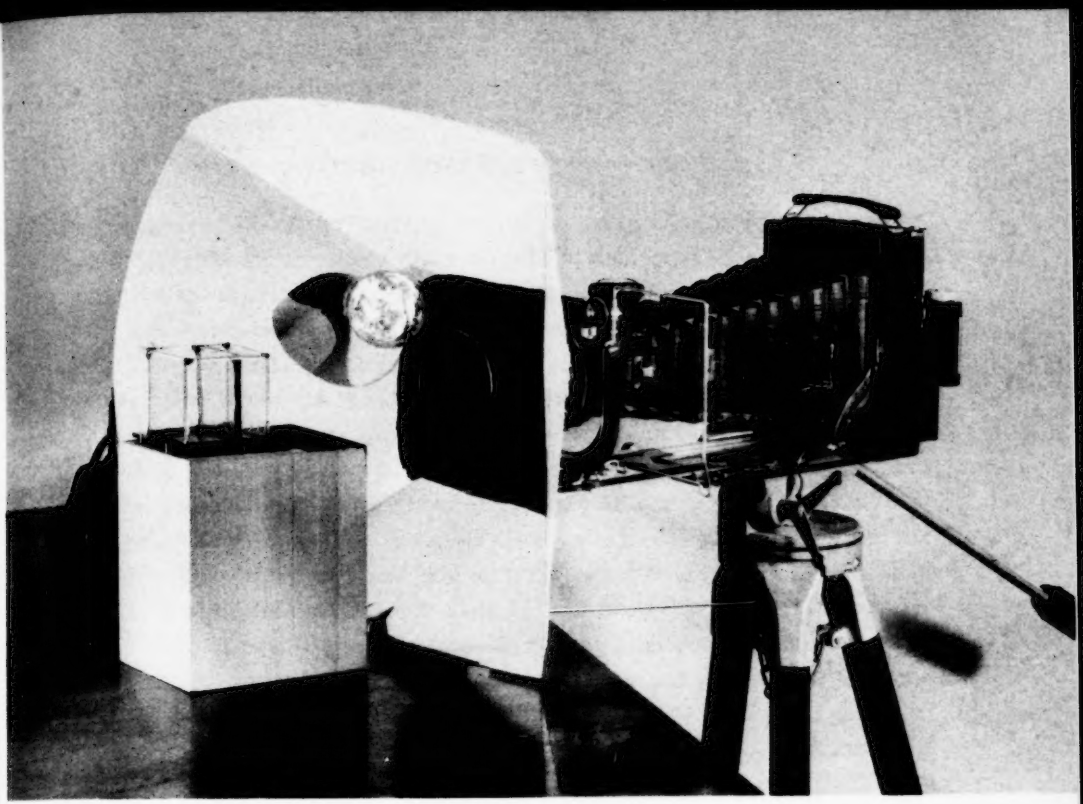
(All made from Kodachrome transparencies with the exception of the set-up)

Figure 1. Guppy.
Figure 2. Photographic Set-up.
Figure 3. Top—*Pristella riddlei;* Left—*Astyanax fasciatus, Lebistes reticulatus* or Guppy.
Figure 4. *Aphyocharax rubripinnis* or *Bloodfin.*
Figure 5. *Platypoecilus maculatus.*
Figure 6. *Aranea.*

of the camera, a small cell was constructed from 2″ x 2″ lantern slide glasses and sealing wax; a compartment was made for the fish 2″ x 2″ x ⅜″. The latter dimension was found to be the practical depth of field for the magnification and aperture used. The camera, with the adapter in place, was focused on a pen point in a position corresponding to 7/16″ from the back wall of the fish compartment. This placed the shutter ring at approximately 9″ from the pen point when the camera was in focus and racked out to its full extent. The field of view embraced, laterally, the center portion of the cell, and vertically, a band ⅛″ from the bottom of the cell to ¼″ below the water level used. Thus, whenever the fish was near the geometrical center of its aquarium, it was within the field of view, and at no time was the subject far from being within the field, especially in a vertical direction. A tank of this size could accommodate easily a fish up to 1½″ long (the camera would have to be moved back, of course, and this yields less magnification). The lens was stopped down to f:32, providing depth of field enough to give a sharp image of the fish, whether it was close to the back or front wall.

The exposure is made with a No. 11 G. E. Photoflash bulb. The light from the direct bulb is so "raw" that spectral reflections from the scales of the fish are overexposed and blank even when the bulb is placed far enough away from the fish to produce serious underexposure in the parts reflecting diffusely. An efficient diffusing system for the illumination may be made by placing a large Kodak Handy Reflector on a lens hood which is, in turn, put over the lens. A hole cut in one side about 4″ from the hood permits the introduction of the flash bulb. One thickness of tissue paper over the bulb adds further softening of the light. Correct exposure results when the bulb surface is 6″ from the fish. (This is about as far away as possible with this setup.) Experiment would yield the correct increase in this distance required if smaller magnification (longer camera distance) were used with larger fish.

The cell is placed upon a level block of wood 5″ high (the pen point is stuck into the block for focusing). Three brads serve as fiducial stops so that the cell may be removed and replaced, and yet maintain correct focus. A ½″ hole is cut in the Handy Reflector just over the lens hood; this enables the photographer to watch the fish for position. The rear inside of the reflector is painted with a 5″ diameter black patch around the lens hood to prevent reflections in the front wall of the cell. To prevent other objectionable reflections from the glass surfaces, the block bearing the cell should be rotated about a vertical axis until no flare from a 60-watt lamp (used to focus) appears on the ground glass in the focal plane. There is, however, a most annoying reflection of the fish at



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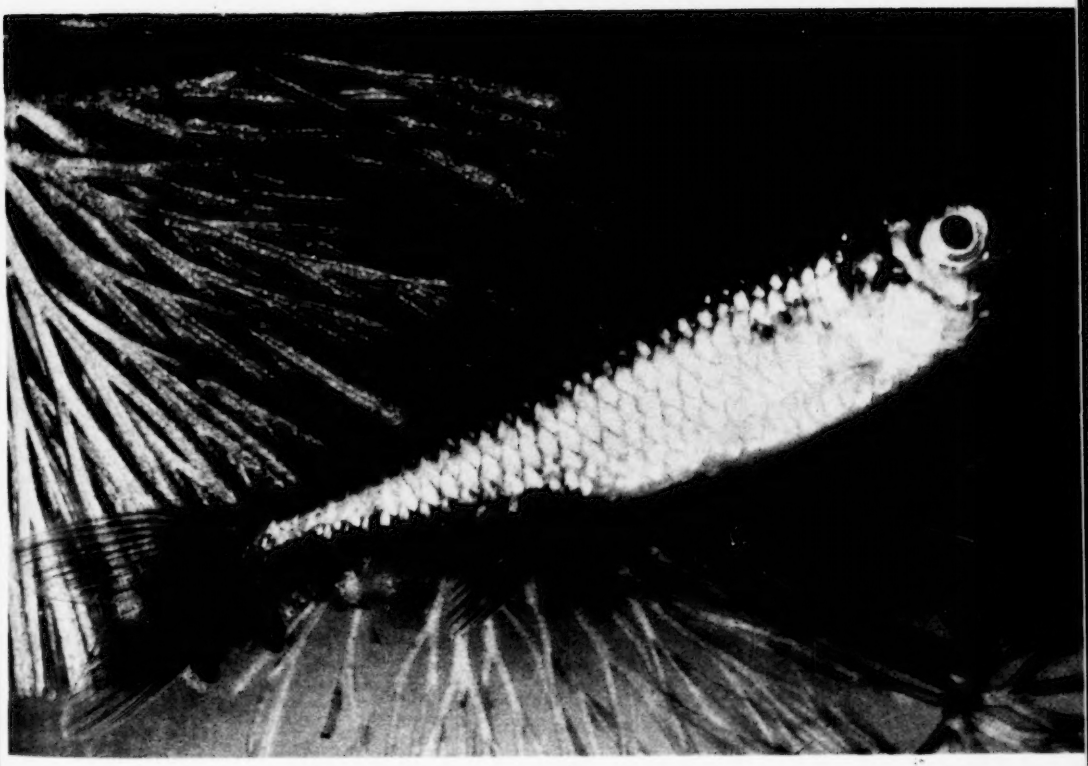

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the glass-air surface of the back wall of the cell to be eliminated. This is prevented easily in the following manner, which also provides for a variety of colored backgrounds for the fish.

The cell is constructed from 2″ x 2″ lantern slide glasses cemented as follows. Three slides are arranged with an H cross section and joined with sealing wax. The bar of the H is ⅝″ from the top and forms the back wall of the fish compartment. Two more glasses are cemented at the top and bottom of the H with a spot of sealing wax at the corner points and with Canada balsam dissolved in toluol along the corner edges. These plates form the front and back walls of the unit. The last glass plate (which is larger than 2″ x 2″) is warmed and coated with melted sealing wax, then the boxed H is placed upon this base to complete the cell. The Canada balsam may melt at this stage, if so, it should be repaired (the edge cementing could be postponed until last). The narrow compartment holds the fish, and the larger one is filled with colored solution to simulate a desired background. A piece of white paper is placed immediately behind the back wall of the unit to reflect light back through the solution. The reason for cementing the four vertical corners of the double cell with transparent balsam is to prevent shadows from falling across the fish or background; this would occur if opaque sealing wax were used.

In case there might be a slight leak between the two compartments, the water level should be 1/16″ higher than the colored solution level; this prevents the chemical solution from contaminating the aquarium, since seepage would be in the other direction. It is wise to cover the entire cell with a small card during the photographic work. Otherwise the clear image of the fish, as seen through the observation hole, might be transformed into a ghostly shape gliding through the chemical solution as a result of an unwise leap on the part of the fish. (This occurred in the case of the author's first specimen. Death resulted in 24 hours in spite of prompt removal to fresh water.)

The solution used in these experiments provided realistic "underwater" backgrounds and was made as follows:

16 oz. water in which dissolve and then filter—
1½ sq. in. Kodak Transparent Water Color Paper, Foliage Green
½ oz. copper sulphate

Weeds for "scenery" may be placed in the fish compartment and gravel strewn on the bottom. However, since the fish often disturbs the placing of the foliage, and sometimes swims on the wrong side of it, the leaves can be

sandwiched against the back wall with another sheet of thin glass. A separate compartment could be built in the background cell to retain the weeds (in water, of course). Again, the background cell could be used solely for weeds, and experiments could be conducted with colored cards if available.

The exposure procedure was this: After focusing and checking reflections, the 60-watt bulb was removed from the socket and a No. 11 Photoflash bulb inserted. The film chamber of the Kodak Miniature Adapter was dropped into place, the lens stopped down, and the shutter opened. The fish was watched through the observation hole in the reflector in dim room light. When it swam into the field of view, the light switch was closed for the exposure.

Use of Urethane with Active Fish

The guppy is such a lively creature that it was found that even during the short duration of the flash noticeable movement occurred. The fish's normal swimming was rather frantic (probably due to the strangeness of its surroundings); it was difficult to catch the fish in the field of view. Hence, a method of anesthetizing the fish was desired.[1] From a paper by F. G. Hall[2] and from a personal communication of November 6, 1938, from Dr. I. C. Gray, experiments with urethane were tried. A 0.4% solution affected the fish in the following manner:

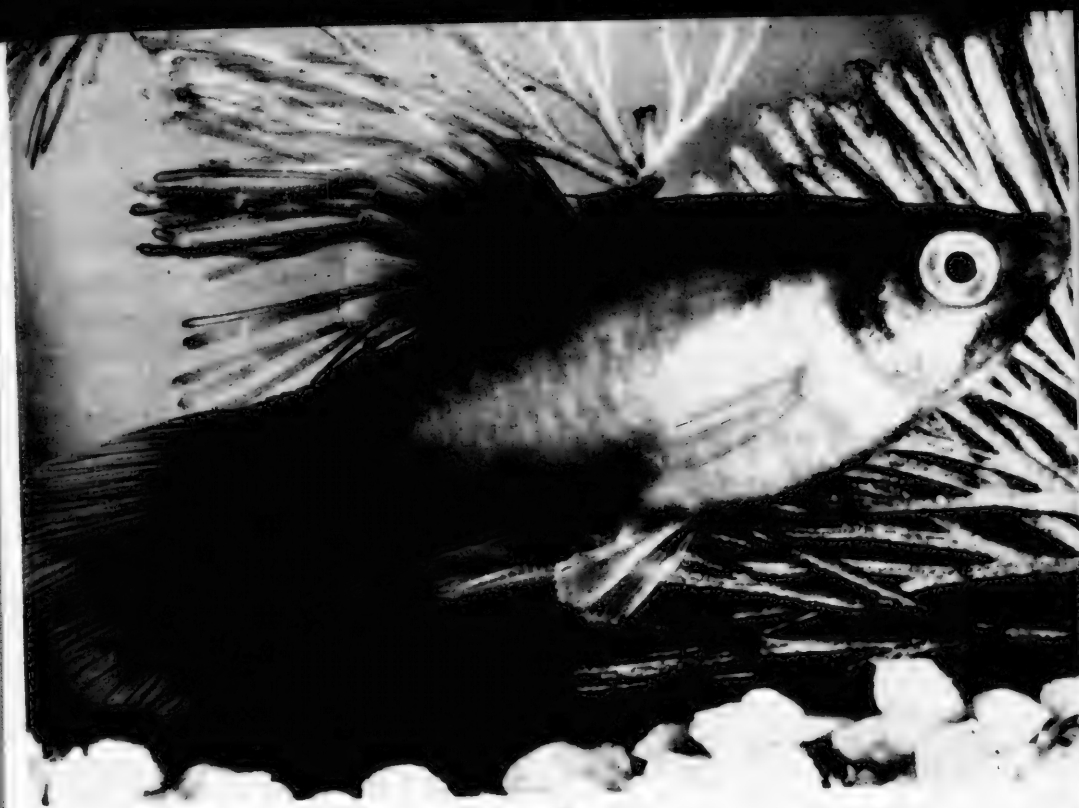
1 min. after immersion—slowed down, regurgitated.
10 min. after immersion—swam sluggishly.
15 min. after immersion—remained on bottom.
25 min. after immersion—inverted on bottom.
45 min. after immersion—status quo on bottom.

Now placed in fresh water:

5 min.—righted.
10 min.—active if disturbed.
15 min.—resumed voluntary swimming.
20 min.—capable of rapid motion.
30 min.—seemed normal.
8 hrs.—normal, no ill effects.

[1] This doubtless would be unnecessary in the case of a sluggish fish, such as the Nile Catfish, or the *Scalares*.

[2] The Influence of Varying Oxygen Tensions Upon the Rate of Oxygen Consumption in Marine Fishes, F. G. Hall, American Institute of Physiology, V. 88, No. 2, March, 1929.



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With this concentration, the period of sluggish swimming (desired for photography) was hardly long enough, as the fish succumbed to the effects of the drug too soon. Accordingly, various concentrations were tried, and it was determined that a concentration of 0.1% brought on the comatose state in about 45 minutes. The fish remained in this condition for observed periods up to 2½ hours. The guppy used, previous to its untimely demise, had survived twelve excursions into urethane intoxication with no apparent ill effects. A concentration of 1.0%, however, proved lethal, for another specimen, in 20 minutes.

When under the influence of urethane, the reaction time of the fish to the flash seems long enough to prevent blurred images in the transparency. Again, the fish swims more slowly and often drifts gradually to the bottom; this makes it easier to ensure that it is in the field of view at the time of the flash, and also that it is moving only very slowly during exposure.

The drug seems to relax the caudal muscles and causes the tail of the guppy to point upwards sporadically. If a natural attitude is to be photographed, it is wise to forego exposure unless a normal swimming posture is assumed. Preliminary experiments upon a *Pearl Danio, Pristella riddlei, Aphyocharax rubripinnis* or *Bloodfin,* an *Astyanax fasciatus,* and a *Red Rasbora* (all active fish) indicate that they react in a similar manner to the drug. However, relaxation causes a downward curving of the caudal vertebrae of these fish, doubtless due to different muscle distribution. The feelers on the jaw of the *Danio* also take on sporadically a walrus-like droop, unnatural to the fish.

The experiment with the *Bloodfin* was particularly valuable and interesting. It is well known that exciting these species causes a withdrawal of the scarlet coloration from the pectoral and dorsal fins, and from the tail. Since the commotion of dipping the fish from the aquarium and transferring it to the cell caused all traces of color to disappear, the author was faced with the apparent necessity of making the exposures after transferring a purged and starved fish to the cell and then waiting several days for the creature to calm down. However, it was found (as the author suspected and hoped) that the urethane had a sedative action; the fish regained its full brilliant color in about 20 minutes.

In all cases, it seems advisable to purge the fish in a separate vessel of about 0.2% urethane for five minutes. This prevents the photographic cell solution from becoming spotty with small particles of food and excrement. The urethane should be purchased from a pharmacy in 1.0% aqueous solution, and the 0.1% solution made up with fresh water at the time of use. The fish is then not subjected to a vitiated respiratory medium.

The Effects of Temperature

The temperature of the solution is most important. If the "water" becomes too warm, say under exposure to the focusing light, the fish obey some instinct that causes them to swim wildly to the bottom of the tank, even when under the influence of 0.1% urethane; this makes good photography impossible. Evidently in their native stream, they swim to the bottom when the surface water becomes too warm. The same instinct also prompts them to jump out of the tank water when it is too cold. From several experiments, a temperature of about 80° F. seems the optimum for the fish mentioned. Whenever the fish seem restless and attempt consistently to swim out of the tank, the temperature should be investigated. Attempts to swim through the walls at various positions in the tank or to jump out indicate that the water is too cold; frantic swimming to the bottom indicates hot water.

Application to Insect Photography

The above photographic procedure is useful also for photographing small insects, such as colored spiders and beetles. It has the advantage of short exposure time for insects that have been etherized and photographed "coming out," and also the advantage of no drying heat for taking pictures of dead insects.

The use of the wide angle supplementary lenses on the Recomars 33 and 18, respectively, makes possible magnifications of about 1½ and 2. Lamp positions and possibly a reflecting system for diffusion would have to be worked out by the photographer. However, data in this paper provide a jumping off point.

For black-and-white pictures, it was found that 828 Panatomic-X Film had sufficient latitude to produce good negatives with the setup for Kodachrome film described above. A few more sheets of tissue paper over the lamp would provide reduction of exposure if desired.

CINEPHOTOMICROGRAPHY WITHOUT A REFLEX FINDER

R. V. DENT, F.R.P.S., F.R.M.S.*

CINEPHOTOMICROGRAPHY with the usual sub-standard cine-camera when there is no provision for viewing the image and focussing on the focal plane, presents difficulties as regards both composing and focussing the image projected through the eyepiece of the microscope. This applies with special force when it is desired to avoid being restricted to a predetermined size of field and magnification, limitations commonly met with in commercial equipment supplied for this kind of work.

There are four standard methods of taking cinephotomicrographs through the microscope, which can be briefly summarized as follows:

1. The use of a pre-set beam-splitter. This necessarily entails the limitations stated above. An efficient type will not absorb more than fifteen per cent of the light which would otherwise reach the focal plane, and it is preferable that there be a means of throwing the beam-splitter out of action when maximum light is required.

2. The use of a variable-focus beam-splitter, which can be focussed after the focal plane of the projected image at the desired magnification has been found. This is the best system of all, but it necessitates a reflex-finder working at the focal plane of the camera.

3. The use of one ocular of a binocular microscope in place of the regular beam-splitter. This is inefficient as it results in fifty per cent loss of illumination. The difficulty of getting an exact focus on the film remains unsolved unless the camera lens is utilized and placed immediately above the eyepiece. This is more of an emergency procedure than one to be adopted as standard practice, as not only is the field severely restricted but the camera lens acts as a degrading factor on definition, in addition to causing further loss of light.

4. The use of a reflex-finding camera direct without a beam-splitter in the path of the rays. This is a satisfactory method of working, and the new magazine cameras with focal-plane focussing accessory can be used in this way.

* Received for publication May 15, 1939. Associate in Scientific Photography, Henry Lester Institute of Medical Research, Shanghai, China.

The method outlined in this paper, original so far as known, was designed for and used with the Eastman Model K camera, and it can be used with any cine-camera which is not equipped with reflex-finder or focussing device. The optical set-up is done as usual on the optical bench, the microscope being used vertically as of course the subjects are living and are usually in a fluid medium.

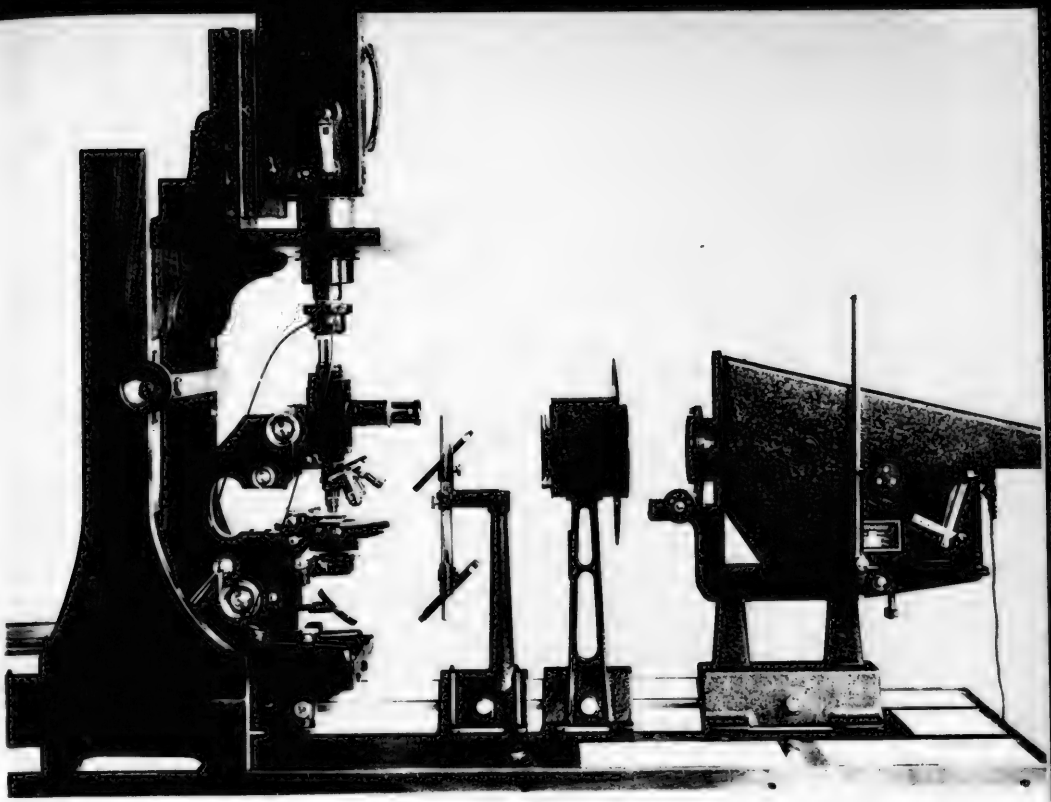
The camera is supported on a stand which straddles the runners carrying the camera, or the triangular runner on which the light, etc., rests; the position naturally depends upon the set-up in use, and therefore the stand must be able to straddle any part of the entire optical bench. This stand, shown in figure 1, has a rack and pinion system permitting the camera to be lowered to immediately above the eyepiece or raised up to ten inches distance. In this way the size of the projected image is under control and at ten inches gives the magnification seen visually through the microscope. Field area is similarly under control as the closer the camera the larger the field.

In the position normally occupied by the lens of the camera the upper half of the usual light-tight connector is attached. The distance between camera and microscope can thus be enclosed by a paper tube of suitable length, fitting into the lower half of the connector which is on the microscope as usual. In practice this was found unnecessary when working in a darkened room provided the camera was shielded from stray light. A card interposed between light source and lower half of camera was found effective.

Figure 2 shows how the camera is supported. A swinging ledge carries both the camera and a small square of ultra-fine-grained ground glass, masked to the size of the film area, in this instance the usual 16 mm. size. The ledge either carries the camera with its lens opening (no lens is used) exactly centered above the eyepiece or the piece of ground glass with its masked opening is centered in the same way. The height at which the ground glass is placed is the position the film occupies in the camera, i.e., at the focal plane of the camera. By swinging the ledge and locking in either position we have in effect a focussing camera with exact control over both field and magnification.

This swinging ledge is not difficult to construct, and although it is essential that the two focal planes should be on an equal level, the tolerance in practice is sufficient to be well within the capabilities of a good carpenter.

This system of working proved satisfactory, and was extensively used prior to the acquisition of the Cine-Kodak Special, which camera has distinct advantages over usual types in scientific work.



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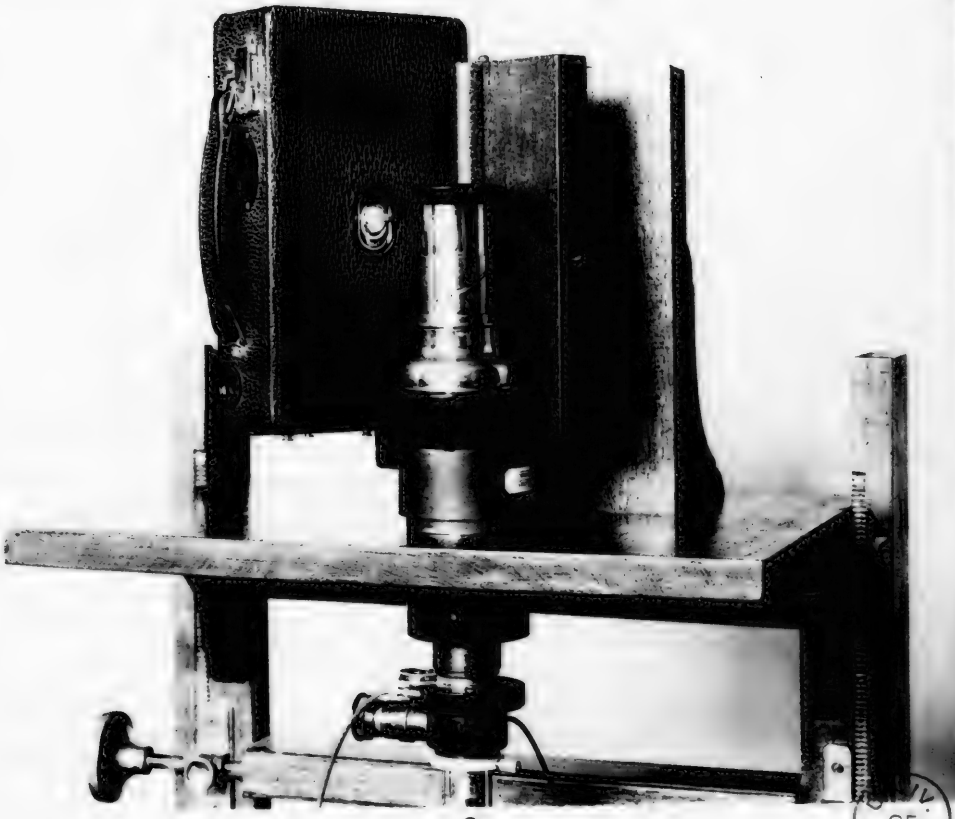

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HOW WE MAKE SURGICAL FILMS

PROF. H. DE LAS CASAS*

Part One

WE believe that surgical filming, as any other surgical work, is a matter of team work, with the surgeon "holding the reins." At least he should do all the planning and editing; he should direct the shooting and supervise everything.

Equipment.

Camera. Our choice went to the Zeiss Movikon, 16 mm., because of the coupled range finder. In Orthopedic Surgery the operating field must be changed frequently, and one should be able to shift the focus without delaying the operation. The Movikon has other features which are of value for titling, animation and diagram work.

Lenses. We generally use the normal (25 mm.) and the 75 mm. lenses. The camera includes other lenses of different focal lengths but we seldom use any of them because they are not coupled with the range finder.

We think the lack of turret is an inconvenience. The lenses have a bayonet mounting, easily set, but the turret would be better. Our best films were shot with two lenses, presenting each scene in the whole and in detail. We like to shoot from the same distance at all times, keeping the 25 mm. and 50 mm. lenses on the turret. As the Movikon has no turret, and the 50 mm. lens is not coupled, we must employ two cameras. The first equipped with the 25 mm. lens, is placed one meter from the field; while the second, equipped with the 75 mm. lens is placed at a distance of 1.50 meters.

It is advantageous to have a third camera loaded and ready in case one of the former runs out of film. The lens from the empty camera is attached to the third.

Changing Bag. The new films, with black backing, can be used to the very end. As sometimes an interesting detail is on the last few feet, we unload in a changing bag. The loading is done in full light.

Illumination. Accustomed to the illumination of still photography, we be-

* Received for publication February 15, 1939. Head of the Department of Traumatic and Orthopedic Surgery, Hospital Vargas, Caracas, Venezuela.

gan with two double lamps. Later we decided to simplify this arrangement in order to follow easily the displacements of the operating field. We use one lamp, with a No. 4 Photoflood, in a silvered reflector, giving a hot spot of controllable size. This single lamp necessitates the surgeon exercising care with the shadows cast by his hands.

The light is kept constant by means of a transformer. Before the operation a photometer reading is taken on a gray cardboard. We prefer the G. E. Photometer because of its narrow angle.

The light is controlled by the surgeon himself, by means of a foot switch. The lighting of the lamp constitutes the signal for the camera-man to start shooting. Switching off the light is the signal to stop.

Towels. The white sheeting used in operations gives a beautiful framing to the field, but only if the exposure is kept rather short. Hence, as in close work it is better to have fully exposed pictures, we used colored towels. Generally they are of a bright red which register as a pleasing shade on panchromatic stock.

Aperture. The towels are clamped to the border of the incision and the operation begins with the white sheets only. Thus it is necessary to change the diaphragm setting. Generally we use f.22 with white and the 25 mm. lens; f.16 with white and the 75 mm. lens; f.16 with red and the 25 mm., and f.11 with red and the 75 mm. lens. The exposure is 1/50 of a second throughout because it is the maximum exposure that will not blur certain movements.

Shooting Platform. It is necessary to shoot from a high point of view. To that end we had a metal framework constructed. Its base is 1.50 meters square; it is 3 meters high. At various heights it has transverse bars, capable of supporting a wooden platform. Generally the platform is placed at a level with the operating table. The first camera is clamped to the bar one meter above that level, and the second camera 50 cm. higher. A stool with three steps is used by the camera-man on which to stand or kneel. The entire framework is covered with sterile sheets.

Camera-Man. A nurse was trained to handle the cameras. She maintains a constant check of the focus on the range finder and keeps the field well centered; she keeps the spring completely wound, and the diaphragm on the correct setting. She announces the footage left, in order not to start an important step without the necessary film.

Each time the lamp is lighted by the surgeon, she begins shooting with the first camera; when the light flickers two or three times, she changes to the second camera, and when the light is turned off she stops shooting.

Role of the Surgeon. We are of the opinion that films taken "by the camera-man," without the control of the surgeon, are wasted. It is important that the surgeon direct the shooting. Only the important steps of the operation are to be taken, and the surgeon is the one to decide on this matter. Also, before each shot, he must think of what he has to do and how to do it without interfering with the light or with the photographic field.

Camera Speed. We began filming as a means of self-criticism; to improve our surgical technic. At this time we filmed almost the entire operation at normal speed, and without paying any attention to the filming. The results were interesting to us but ugly and boring to anybody else, and worthless as a teaching medium. Today our aim is to make didactic films and act accordingly. In the first place, we do not attempt to film any irregular operation or one with which we are not familiar. Only the important parts are shot, some at varying speed. Generally, as we operate very slowly during the shooting, the camera is run at 12 frames to avoid a "dragged" projection. Sometimes, on the contrary, when we wish to emphasize a step, the speed is increased to 24 frames. Generally it is the shutter and not the diaphragm that is changed, because at 12 frames, with 90° shutter aperture the exposure is 1/50 second and at 24 frames and 180° shutter opening it is also 1/50 second.

The Processing.

Although there is at least one good processing station in town, we prefer to do the processing ourselves. It is not easy to take advantage of all the possibilities of the cinematograph without being able to do all the processing. Also, the commercially processed films are not better than those we process.

The reversal method is employed. As we do considerable editing, we would like to keep the untouched negative, but failed with the negative-positive method. A full rich scale together with fine grain could not be obtained. To keep the graininess low we had to sacrifice the "snap." Also, the dust particles and scratches showed too much.

We went back to the reversal system and when a duplicate is made it is also by reversal process. Frequently the duplicate is better than the original because the contrast or intensity can be modified. Even the dust and scratches are less conspicuous with the reversal method; in the negative-positive they give transparent images, and a phenomenon of irradiation makes them too visible.

Film. Satisfactory results have been obtained with many makes of film. Even negative emulsions, treated by reversal, give fine results. Also, in broad

daylight and when color sensitivity and depth of focus are not of prime importance, we use positive stock, except for operations.

We prefer Gevaert Pancho Reversal Super which has every quality found in other emulsions, plus a remarkable resistance to heat and scratches. It would be a nuisance to cool the solutions, and Gevaert film can be developed at 26° C. without any swelling or loss of quality.

Processing Apparatus. A drum was constructed. Two discs of hardwood, 65 cm. in diameter, are mounted on an axle and joined with 50 glass rods 40 cm. in length. The axle rests on two ball bearings on two posts which are "Y" shaped. These posts are fixed by nuts and bolts to the sides of a semi-cylindrical tank in which solutions are poured. The tank has the necessary water and drain connections. The axle has, at one end, a bicycle wheel operated by a small electric motor. We will not describe the apparatus in detail because it is very well known, but we would gladly send the data to anyone interested.

Processing Solutions. First Developer. We use a Metol-hydrochinon formula with Ammonia as alkali (1).[1] The Ammonia is added just before we use it. It has 0.02 of Green Pynacriptol by liter, not as a desensitizing agent but to avoid the aerial fog.

Gevaert recommends a different formula, with Caustic Soda and Carbonate as alkalis. Only a few months ago they accepted Metol in the first developer (2). As we wanted soft results, we used Metol from the start. However, the Metol formula has its inconveniences. Metol is a fast developer and above all, the image begins to appear very soon. As the developing time is determined according to this "starting time," any error is important. The original Gevaert formula (3), without Metol, has a much longer starting time. The time of development is about eight minutes at 23° C. with normal exposure; in this case the highlights appear after some 12 seconds.

Bleacher. We use the standard Bichromate and Sulphuric Acid formula (4). If the film is well washed, the action is almost instantaneous. After two minutes the lights can be put on.

Clearing Bath. Strictly, the Ammonia Developer avoids the necessity of this bath, which is indispensable with other alkalis. However, we think it safer to use it. It is a plain solution of a 10 per cent Sulphite of Soda that can be used several times. The solution can be much weaker, 1/30. Perhaps the best method is to use the weak solution only once.

[1] Numbers in parentheses indicate that formulas may be found in the Appendix.

Redeveloper. The first developer can be used again. It has weakened, and since the Ammonia has been partially evaporated, it will act as a soft developer. However, we obtain finer results with another formula (6). Sometimes we use special formulas, as will be explained under "Control of the Processing."

Fixing and Hardening. It is said that the reversal process does not require fixing, because the whole of the silver is reduced in both developments. In practice this is not true: after the second development there is still a certain amount left which will vary with the make of the film. Were it not so, the second developer would not need any bromide. We use the Kodak F5 formula which hardens very well. It is safer to use the bath only once.

Modus Operandi. In complete darkness the film is mounted on the drum. It must be tightly wound, because it lengthens in the solutions. Our drum has eight rods mounted on rubber elastics which take up the slack of the film. The ends of the film are attached to rubber elastics, one having a hook that is anchored on the drum rod while any suitable means of clamping the film may be used at the other end. We use suture clips named "serrefines." It is a good idea to staple together the film and the rubber band. The mounting is inspected with a dim green light: a flashlight with undervolted lamp and 5 ply Virida paper (Lumiere).

The developer is poured without pre-soaking and the time elapsed for the first appearance of the image is counted while inspecting the film from time to time. As the film cannot be desensitized, this inspection must be very carefully done, avoiding long exposure to the light, even if it is very dim.

The film without black backing can be desensitized; when the black backing was introduced the manufacturers said that it could not be desensitized, but after a few months they said it could be. However, it is dangerous, for sometimes the film is completely spoiled. The final result appears as if the film was veiled. It is not the effect of the acceleration of hydrochinon by pynacriptol because the edges are cleared also. We do not know what happens.

At the end of the required time (40 times the "appearing time" with our formula), the developer is drained and the film washed thoroughly; then the bleacher is poured.

Stop-Bath. Gevaert does not advise the use of the stop-bath, stating that its acidity stains the film yellow. We have not experienced the same result; there is a slight yellow stain, barely noticeable, with or without the stop-bath. However, as the Gevaert films are not swollen in the developer, the stop-bath is not necessary. With any other make of film we use it (9).

The bleacher discolors a well-washed film in a few seconds. At the end of

two minutes the lights are put on, even if the film is not bleached. In any case, the development has stopped. The bleaching is continued for at least five minutes. If at the end of this time the reduced silver is not dissolved, the film is washed for several minutes and a new bleacher poured. That means the bath was exhausted or the film was not well-washed. One cannot overemphasize the necessity of washing the film completely between the baths for it is essential for good results.

Then follows bleaching, new wash and clearing. The clearing lasts at least three minutes with fresh solution, more than three minutes if there are stains.

New washing and second development. This bath will indicate if the film was well washed: it blackens in a few seconds. However, the development must be continued for at least five minutes or unevenness will result.

New wash and fixing. It is difficult to judge if fixation has taken place. It can be judged by the hardening, as is shown by the dry appearance of the emulsion while out of the bath at each revolution of the drum. However, this is a rather difficult method. It is much better to use the bath only once.

We use the bath only once. Hence our drum is constructed to use only one liter. The only bath that can be safely used a few times is the clearing bath, however, it is even better to make it weak and use it only once. An exception is made: the first developer, already used, can be used as second developer but should not be used fresh as second developer except in special cases.

After fixing, the film is washed in running water, with the drum revolving at a fair speed for at least one hour.

Working with colored solutions we found that running water is not better than changing the water, it is only more convenient.

The film must be squeezed almost dry with a chamois leather, well soaked and expressed. We prefer this leather to the viscose sponge which sometimes leaves small particles on the emulsion. The leather should be very clean, frequently boiled.

The film is then hung up to dry. We use a rack made of two frames mounted on the same axle. By modifying the relative position of the frames, the film is loosened and permitted to shrink. The frames must be very clean and well polished to avoid scratches. The rack is placed in front of a window protected from dust with a gauze curtain.

We use a revolving drum for drying but it is dangerous with loosened film. Also it is not necessary, for well squeezed films dry in about ten minutes.

The film must be left at least 24 hours, loosely rolled, before passing through the projector. Otherwise it is liable to be scratched, and as it does not glide freely, the loop is lost and the sprocket holes are apt to suffer.

Control of the Reversal Process. We have heard much about automatic control as practiced in processing plants. They say that the principle is to expose the bleached film to an amount of light proportional to its transparence—therefore to the exposure in the camera. The films underexposed in the camera would have little of their unreduced silver left after the bleaching, reduced by the second exposure and the second developer. The overexposed films on the contrary, would have much of that silver blackened.

Our means of control are limited. We can change the time and sometimes the formula of the first developer and the formula of the second developer.

Control by the First Developer. We said that the development time is determined according to the "starting time," that is, to the time elapsed before the first signs of an image appear on the film. Normally the starting time is 12 seconds at 23° C., and the development time eight minutes. The factor (known as Watkin's factor) is 40.

Control is accomplished by the following factor: an underexposed film will have a longer starting time, which, multiplied by 40 will give a longer development time. The reverse will apply to overexposed films. This factor is dependable for use on average subjects containing strong highlights which are of little importance.

Even with this limitation there is still another inconvenience especially with our formula and all formulas containing a good proportion of metol; any error will be multiplied by the high factor. If the developer contains only Hydrochinon as reducer the factor is lower and the error less important. With the old Gevaert formula (3) the factor is 10. For this reason, if we are not certain of the exposure and if the subject will not be spoiled by an increase of contrast, and if the shadow detail is not very important, we use the Gevaert formula (3).

With any of them it is possible to develop underexposures for about 30 minutes and overexposures for as little as 3 minutes. This affords some control, yet satisfactory quality can be obtained only with correct exposure and normal development.

It is also possible to develop underexposures with more alkali. If the starting time is very long the bath is drained and a fresh one with double proportion of Ammonia is poured.

The BJ Maximum Contrast Developer (10) can also be used. In a few tests we made it proved more energetic than the BJ Maximum Energy (7).

Control by the Second Developer. Control cannot be affected by changing the time of the second development. Increasing development does not help and decreasing it is liable to result in unevenness. We prefer to change the formula. In case of overexposure, the density can be increased slightly by

the use of BJ Maximum Energy Developer (7). However, the results are better by intensifying the film after completing the processing.

In case of underexposure we use Rawlin's Soft Developer (8) (a formula compounded for infrared microphotography of contrasty subjects). Its action tends to soften the hard results of underexposure and overdevelopment. This formula gives beautiful results and we use it frequently even in well exposed films when softness is desirable.

Intensification and Reduction. Slight errors can be safely corrected but great errors can result in failure with intensification and reduction. Great intensifications are liable to produce stain while deep reductions easily become excessive. Among the safe methods of moderate action which will not spoil the half tones we have chosen a solution of Perchloride of Iron (11) as a reducer. The film is well soaked and immersed. The reduction becomes visible after passing through a plain fresh solution of hypo. As the reduction cannot be followed, it is necessary to make a previous test with a few frames, counting the time of immersion. The film takes on a warm brown tone which is not displeasing. The procedure can be repeated several times thus making it convenient to proceed by steps. Intensifier. We prefer the Lumiere Formula with Bi-iodide of Mercury (12). The film is simply immersed in the bath and the intensification followed by sight. The image is not stable unless passed through a developer after intensification. The tone becomes a pleasing blue-black.

Other Methods. Among the less safe but more energetic methods, we like: Gevaert Reducer—Permanganate of Potassium (13). The film becomes stained a brownish color which makes it impossible to see the reduction. The stain is removed by Bisulphite of Soda and the reduction becomes apparent. As with the Perchloride reducer, it is necessary to make a previous test. The reduction can be carried further than with the Perchloride and the color is not changed. However, this formula is treacherous for sometimes the results are different on the test than is produced on the whole of the film. Gevaert Intensifier (14), contains Nitrate of Silver and a reducer. The intensification is very strong and rapid and the tone is a beautiful blue-black, but stains occur frequently. In order to avoid the stains the following measures can be taken: 1. Thoroughly wash the film; 2. If there is any doubt about fixation or washing of the film, fix it in fresh hypo, wash one hour and pass through a bath of Potassium Ferricyanide to destroy any traces of hypo (15). This bath is a reducer and should be used only for about a minute with thin film; 3. Mix and use in subdued light; 4. Do not allow the film to remain in the bath after all

the silver has been precipitated for more than five minutes or a gray deposit will result; 5. Do not allow any metal to come in contact with the bath. After the intensification the film is passed through fresh acid hypo, washed thoroughly and any silver dust adhering to it is removed with a cotton swab.

Persulphate Reducer (16). Persulphate of Ammonium has the advantage of not attacking the half tones. This makes it valuable but it sometimes produces unevenness, especially with hardened films. It should be used only on films not hardened.

Line Intensifier (17). This intensifier acts only on the densest parts of the image thus increasing the contrast. This makes it valuable for line work. Its active component is lead nitrate.

Farmer's Reducer (18). Increasing the contrast should be used only for titles and drawings. It can be also used to diminish the fog, especially the fog produced by long development.

All these means of control and correction are valuable in the case of a film that cannot be retaken, however, the best results cannot be compared to the quality of a correctly exposed and developed film.

Because of the uncertainty of the above mentioned methods, a duplicate film should be made before proceeding. We assume that only valuable films are worth the effort of attempting corrections.

Appendix. Formulary.

1. First developer. (Our formula.)
   Metol 4 gr.; Hydrochinon 6 gr.; Sulphite (dry in all formulas) 70 gr.; Bromide 4 gr.; Water to 950 cc. Add 0.02 Green Pynacriptol dissolved in a little water. Just before using, add 10 cc. Ammonia 37–50% (or equivalent in other dilution). Make the total volume 1 liter.
2. Gevaert, new formula for first developer.
   Metol 4 gr.; Hydrochinon 6 gr.; Sulphite 70 gr.; Carbonate 35 gr.; Bromide 10 gr.; Potassium Sulphocyanide 3 gr. Water to liter. To 950 cc. add, before use, 50 cc. of Caustic Soda 10% solution (5 gr.).
3. Gevaert, old formula.
   Hydrochinon 10 gr.; Sulphite 70 gr.; Carbonate 35 gr.; Bromide 8 gr.; Sodium Hyposulphite 2 gr. Water to 1 liter. Add Soda as to formula number 2 above.
4. Bleacher. Potassium Bichromate 5 gr.; Acid Sulphuric 5 cc., 9 gr. Water to 1 liter.
5. Clearing bath. Solution of Sodium Sulphite 10%. It can be 3% if used only once.
6. Second developer. Metol 3 gr.; Hydrochinon 3 gr.; Sulphite 20 gr.; Carbonate 20 gr.; Bromide 2 gr. Water to 1 liter (Gevaert).
7. Maximum Energy Developer. (B. J.)
   Methyl Alcohol 48 cc.; Metol 14 gr.; Sulphite 52 gr.; Hydrochinon 14 gr.; Bromide 8.80 gr.; Caustic Soda 8.80 gr. Water to 1 liter.

8. Rawlin's Soft Developer. (Infrared Photography.)
   Metol 1.50 gr.; Potassium Metabisulphite 1.50 gr. Water to 500 cc. Sulphite 9 gr.; Carbonate 6 gr.; Bromide 0.25 gr. Water to 500 cc. Mix the two.
9. Stop Bath. Chrome Alum 30 gr. Water to 1000 cc.
   Alternative: Chrome Alum 20 gr.; Sodium Bisulphite 20 gr. Water to 1000 cc.
10. Maximum Contrast Developer.
   Hydrochinon 22.50 gr.; Bisulphite 22.50 gr.; Bromide 22.50 gr. Water to 500 cc. Caustic Soda 12.50 gr. Water to 500 cc. Mix just before use.
11. Proportional Reducer.
   Iron Perchloride 6 gr.; Hydrochloric Acid 1 cc. Water to 1 liter. Immerse the film, pass through a 10% solution of Hypo.
12. Proportional Intensifier. (Lumiere.)
   Mercuric Iodide 10 gr.; Sulphite 50 gr. Water to 1 liter. Wash, pass through a standard developer.
13. Gevaert Reducer.
   Potassium Permanganate 2 gr. Water to 1000 cc. Clean in Hypo 10 gr.; Bisulphite 15 gr. Water 1000 cc.
14. Gevaert Intensifier.
   Water 1000 cc.; Hydrochinon 10 gr.; Acid Citric 6 gr.; Water 1000 cc.; Silver Nitrate 15 gr. Wash before using. Pass to an acid Hypo bath.
15. Hypo elimination.
   Potassium Ferricyanide 2 gr. Water to 1 liter. Not more than ONE minute!
16. Persulphate reducer.
   Water 1000 cc.; Ammonium Persulphate 30 gr.; Sulphuric Acid 1 drop. Pass to a 10% Sulphite solution.
17. Line Intensifier.
   Bleach in: Lead Nitrate 42 gr.; Potassium Ferricyanide 62 gr. Acid Acetic 20 cc. Water to 1 liter. Wash a moment in Nitric Acid 10%. Wash well in water. Develop in 5% solution of Sulphite.
18. Ferricyanide Reducer. Water 1000 cc. Hypo 100 cc. (10%). Water 1000 cc. Potassium Ferricyanide 100 cc. Mix 95 cc. of Hypo solution with 5 cc. of Ferricyanide solution.
19. Title contrast developer.
   Hydrochinon 12 gr.; Sulphite 75 gr.; Carbonate 100 gr.; Bromide 5 gr. Water to 1 liter.
20. Developer for duplicating by reversal (soft).
   Metol 1 gr.; Sulphite 20 gr.; Hydrochinon 3 gr.; Carbonate 17 gr.; Bromide 1 gr.; Potassium Metabisulphite 5 gr. Water to 1000 cc. It is good to add 0.02 Green Pynacriptol. Use as second developer number 8 above.
21. Film Cement.
   Ether Acetic 100 cc.; Acetone 100 cc.; Acid Acetic 2 cc.; Film base 2 grams.
22. Film Cleaner.
   Pure Carbon Tetrachloride (the safest).
   If particles are difficult to remove use: Ammonia 5 cc.; Methyl Alcohol 15 cc. Water to 100 cc. (Morgan). It is primarily a cleaner for celluloid but does not harm the emulsion of black and white films.

STEREOPHOTOGRAPHY WITH SPECIAL REFERENCE TO GROSS SPECIMENS

WILLIAM L. M. MARTINSEN*

ODD as it seems to one who has derived both benefit and pleasure from stereoscopy, many will not read beyond the caption to this paper. To them, stereoscopy is relegated to some previous generation when folks would gather in the parlor to view sepia-toned prints of places of mutual interest. We do not pretend to know why this should be. That stereoscopy has demonstrable value is shown by its general acceptance in numerous branches of science, in many of which it has opened up entirely new avenues of research. Yet, to many medical photographers and general biologists alike, the mere mention of stereophotography causes an expression of surprise. Notwithstanding, we can think of no branch of science where it might be more advantageously employed.

Wherever the shape of an object has the slightest value for record purposes, the use of stereoscopy is indicated. The most treasured specimen will live again with renewed splendor each time it is viewed in a stereoscope. How much added information is given when each important detail is clearly presented and each plane recedes to its own level! It has been aptly stated that "The stereoscopic photograph is as informative as the object itself."

Before going into a discussion of the photographic phases of the subject, it seems desirable to take a moment to review a few of the fundamental principles underlying stereoscopy.

Stereoscopic perception is possible only because of our binocular vision. It is the horizontal arrangement of our eyes plus their faculty of accommodation and convergence which makes possible the phenomenon of third dimension.

Hence, it is evident that a monocular individual cannot perceive anything in third dimension. If such a person does possess this ability, it is because of other faculties of the eyes—mainly, perspective and parallax.

We are all familiar with the effect of perspective upon distance. While the effect of perspective is always present, parallax (monocular) is dependent upon some degree of movement. Although its effect as an indicator of distance and

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relative position is perhaps not as commonly realized as the former, yet we have all observed as we move about how one object is apparently displaced with reference to another. Needless to say, there is a relationship between the degree of motion observed and the relative position of the objects. Also, when coupled with very active accommodation, parallax furnishes man with a quite reliable guide for estimating distance. If we now add to this, color and shadow pattern, we begin to see how a monocular individual might experience a sensation of distance and obtain a feeling of shape. However, this is not stereoscopic vision. It is the sensation we all experience when we look at any well made two-dimensional photograph. To appreciate this difference it is only necessary to view a single component of a stereogram and then view the whole in a properly constructed stereoscope. To use the words of the eminent Oliver Wendell Holmes,[1] "The effect is so heightened as to produce an appearance of reality which cheats the senses with its seeming truth."

The role binocular vision plays in stereoscopic perception has been the subject of much investigation. Helmholtz[2] has demonstrated that the interpupillary separation causes dissimilar images to be projected on our retinae, and that the merging, by our minds, of these images, gives rise to plasticity. He has further shown that as the distance between the object and the observer increases, plasticity decreases. This is because distant objects require less convergence. The visual axes are more parallel and the retinal images become more and more alike until we are no longer able to detect any difference. When that occurs, stereoscopic vision has ceased to exist. Plasticity is annihilated. Conversely, as the distance between the object and the observer decreases, plasticity increases.

There is, then, both a far point of zero and a near point of maximum plasticity. It is with the latter that we shall concern ourselves mostly. By conniving to take advantage of the increased plasticity afforded by a near viewpoint, maximum depth may be imparted to our stereograms. This is relatively simple. We have already shown that as the distance between an object and the observer decreases, plasticity increases. It follows, then, that there must be an optimum distance at which stereoscopic perception is at its maximum. This is actually true but according to Dr. May[3] the nearest point at which the nor-

[1] Holmes, Oliver Wendell, "The Stereoscope and Stereoscopic Photographs," 8th Ed., p. 16.

[2] Helmholtz, H., "Physiological Optics," translated by J. P. C. Southall, Vol. III, pp. 310–315.

[3] May, Charles H., "Diseases of the Eye," 11th Ed., 1924, pp. 370–377.

mal unaided eye can clearly perceive detail without strain, changes as age progresses. Being very near, 2–3 inches in early life, it recedes until at the age of fifty, the object must be about sixteen inches away; at seventy-five, only objects at infinity can be clearly seen. This is a normal physical process and should be reckoned with in the design of equipment for use in stereophotography.

However, it is evident that no variable factors such as we just mentioned can ever be the basis for anything, and it is therefore necessary to adopt a definite viewing distance, which is admittedly a compromise. Kurtz and Bridge,[4] and more recently Sherwood,[5] have suggested that the adoption of an optimum viewing distance of fifteen inches would allow for variations in the accommodative power in different individuals.

Accepting this distance as a basis for our computations and placing the average normal interpupillary separation at two and a half inches, the visual axes converging upon the object will subtend an angle of approximately 10° (actually 9° 32′). This relationship may, perhaps, be more conveniently expressed as the ratio between object-distance and interpupillary separation; or, in the case of stereophotography, as the ratio between object-distance and lens shift. If this ratio of six-to-one is employed in photographic practice, the images upon recomposition in the stereoscope will possess a degree of plasticity commensurate with a fifteen-inch viewing distance. This obviously holds true for any object-lens distance.

It is probably evident to many by this time that the system here elucidated is the one commonly referred to as a hyperstereoscopy. This system has been defined by Judge[6] as "the method of employing a different lens separation from that of the eye." That is to say, the lens separation varies with changes in object-lens distance.

Gross Specimen Work. Relatively few types of work encountered in the laboratory make such demands upon flexibility in equipment as do hyperstereoscopy of gross specimens. This is principally due to the great variation in object size encountered in this type of work. Needless to say, there is a direct relationship between object size and object-image distance. This is assum-

[4] Kurtz, Henry F. and Bridge, Ezra, "A Method of Precision in Stereoscopic Roentgenography," *Am. J. Roent.*, XVIII, 4:370–377, Oct. 1927.

[5] Sherwood, H. F., *J. Biol. Phot. Assn.*, VI, 2:78–84, 1937.

[6] Judge, Arthur W., "Stereoscopic Photography—Its Application to Science, Industry and Education," 2d Ed.

ing, of course, that the image is to fit within a predetermined area as is usually the case in this kind of work where the pictures seldom exceed 3″ x 3″.

Thus with each change in the object-image distance we are confronted with the problem of providing a corresponding lateral change in the lens position, thereby maintaining our six-to-one ratio.

In order to quickly and accurately make these adjustments, we have constructed a piece of equipment—a sort of sliding camera base.

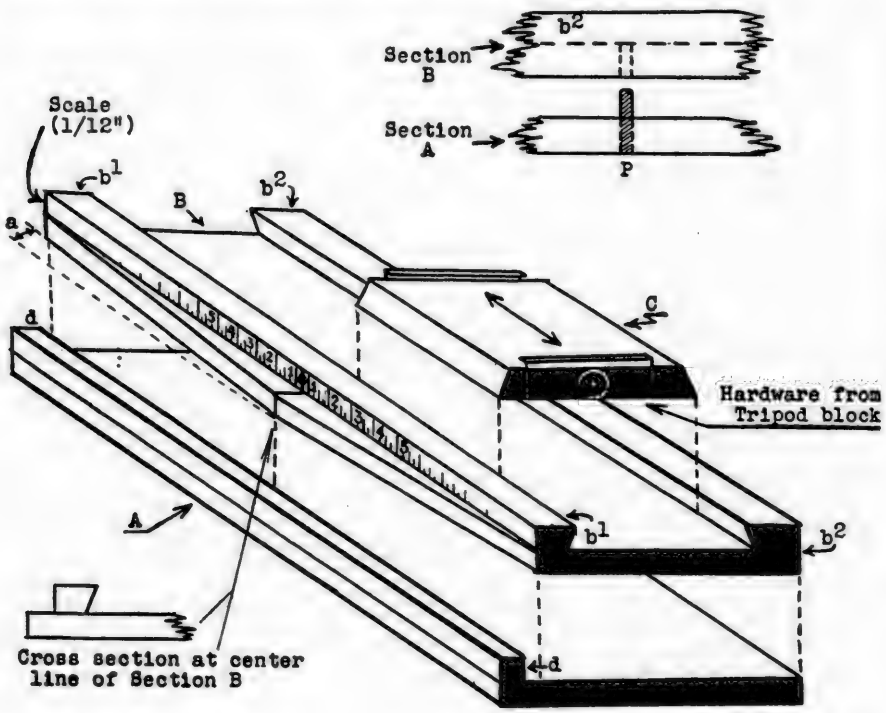

FIGURE 1.

While there is nothing particularly new in the idea of a sliding camera base, perhaps the simplicity of this one might appeal to some. In figure 1, is shown an oblique construction of the whole assembly. It is made up of three sections —a baseboard, A; a center section, B; and the sliding camera base-plate, C. The latter was designed to ride between two beveled guide strips, b1 and b2, thus providing for a lateral lens shift. The center section, B, by its construc-

tion, automatically provides the correct convergence angle. The way this is accomplished is shown in figure 2. The upper edge (the back of the assembly)

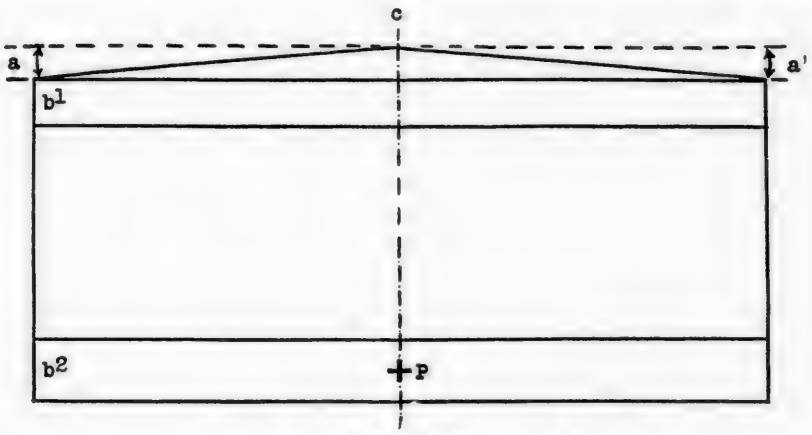

FIGURE 2—PLAN OF SECTION B.

has been fashioned to form two angles (a and a′) with their apices meeting at the center-line, C. Some distance to the front on this center-line is placed a pivot, P.

If we now turn to figure 3, we see the complete assembly with the camera in position. With the help of this figure we will describe the movements necessary to make a set of stereograms.

The camera, on its sliding base, is moved to one side of the center-line (let us say right) for a predetermined distance. We may express this distance as $\frac{r}{2}$, where r is the ratio of six-to-one. This again is equal to one-twelfth of the object-image distance. Section B, figure 1, is then rotated on its pivot, P, as indicated, until it is stopped by the back-stop, d, on the baseboard. The optical axis now coincides with, and is in fact, the convergence angle. The first exposure is made and the camera moved to its second position an equal distance to the left of the center-line. Here the optical axis is again rotated inwards and the second exposure made. This constitutes the entire operation, and, as is usual with this sort of thing, it takes more time to describe it than to actually do it.

Regarding construction details and dimensions, we feel that, due to the great variety of camera equipment in use by photographers, no dimensions are

given. Instead, a few words added to what has already been said should enable the individual worker to plot the equipment to fit his own camera, whatever its size and make.

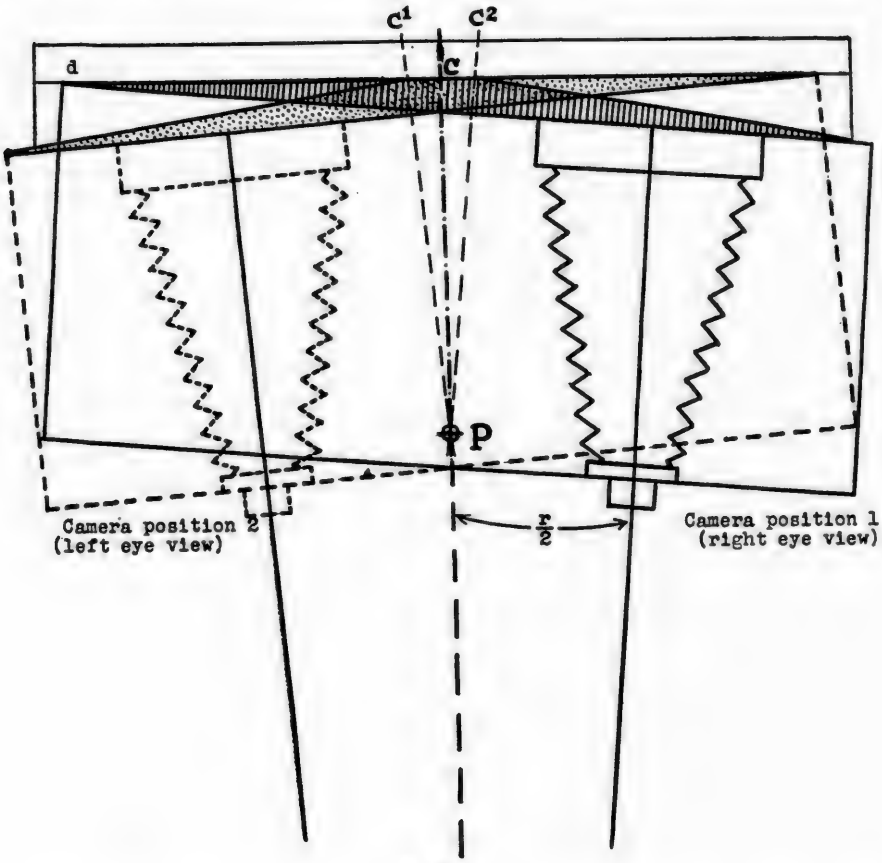

FIGURE 3.

The angles a and a′, figure 2, govern the convergence angle. Their combined values must, therefore, equal the convergence angle. This would make each subtend an angle of 4° 46′. However, unless the apparatus is constructed of metal, such accuracy can hardly be hoped for and is perhaps not necessary. A subtense of 5° seems sufficiently accurate for most purposes. Another way of obtaining the correct angle is to consider its base as being one-twelfth of the distance from apex (at c) to base.

Regarding the size of the equipment, we might say that the (lateral) width

of the center section equals the maximum camera shift required plus the lateral dimension of the camera to be accommodated.

In order to establish maximum shift it is first necessary to know the object-image distance for the largest object likely to be encountered in routine photographic practice in the laboratory. This distance may be calculated by use of the well known formula:

$$D = f\left(r + \frac{1}{r} + 2\right)$$

where D = the object-image distance
f = the focal length of the lens
r = ratio between image size and object size.

From the figure obtained, the necessary camera shift is calculated employing the ratio of six-to-one. Add to this the lateral dimension of your camera and we have the complete width of the apparatus.

The (anterior-posterior) depth of the equipment along the center-line, c, is principally determined by the A-P dimension of the camera. To this is added the width of the base of the angle, a, and the combined width of the strips, b1 and b2. The pivot, P, is located anywhere towards the front on the center-line, c.

All that now remains to finish the center section is to add a scale for convenience in shifting the camera. The simplest scale for this purpose is a foot-rule with the inches subdivided into twelfths. On this scale every foot of object-image distance requires a shift of one inch to each side of the center-line and every inch of distance a shift of one-twelfth of an inch. Two scales should be made, one reading from left to right and the other reading from right to left. These scales may then be mounted with their zero points together on the rear of the strip, b1. However, before mounting them it is necessary to make a correction for the offset of the center-line, c, to its alternate new positions, c1 and c2, see figure 3. This offset is caused by the rotation of the camera when converging upon the object, and totals one-sixth of the distance, c-P. Since the offset takes place in the same direction as the camera movement, the correction is made by shortening each scale by an amount equal to one-twelfth of the distance, c-P. This correction must be made at the beginning of each scale, otherwise the lateral camera shift will always be that much in excess of the intended six-to-one ratio.

The two remaining pieces of the assembly should not need any explanation. The baseboard, A, figure 1, is just that and no more. It holds the pivot at the front and has a wooden strip, d, mounted at the rear. The sliding camera base-plate, as illustrated, was fitted with hardware of the type found on the

well-known sliding tripod blocks. This offers a simple way of mounting a camera of the view or commercial type. However, owners of cameras of a different design should have no difficulty in designing a sliding camera base-plate to fit their own instrument.

We hope the above description has not made the equipment sound involved. It is not. Anyone at all familiar with the use of simple tools can construct the camera slide in a few hours at practically no cost.

While it is preeminently suitable for work with gross specimens, it has some shortcomings inherent with all one-lens systems—it is not suitable for photography of anything which is subject to motion. Hence, it is of little value in clinical work. The attention of those who may wish to combine work of this type with their gross specimen work is, therefore, called to a camera described by Weingart and Sage.[7]

This camera is a twin lens, reflex type camera, in which both pictures of the stereogram are produced simultaneously on one film. Provision has been made at the front for varying the lens separation. This gives some control over the convergence angle and makes possible close-ups of lesions and smaller objects. In fact, they claim ability to work up to nine inches from the subject. This is, of course, impossible with the standard stereocameras using a fixed lens separation.

Without getting ourselves deeply involved in geometrical equations, let us now stop a moment to examine a few of the conditions which must be met, if we are to obtain a reasonably truthful stereoscopic rendering of our subjects.

In this age of short focus lenses we hear a great deal about (linear) perspective. Whenever a negative exhibits an unusual degree of difference in size between near and far objects, we are told that the perspective is wrong and that of course the fault lies with the short focus lens. The truth of the matter is that when the perspective appears violent the fault is not with the lens at all, but with the man behind it; and the perspective is not wrong, in fact it is quite correct! The fault, if such it be, lies in the viewpoint (or object-lens distance).

In our standard text-books on optics and physics, we read statements to the effect that the center of the entrance pupil is the point of view which determines the perspective of the image. In other words, as the distance between the entrance pupil and the object increases or decreases, the angle subtended at the entrance pupil, by an object of given size, will proportionately increase or decrease. Hence, we see that linear perspective remains identical for any given object-lens distance regardless of focal length. The function of focal length then

[7] Weingart, Julius S. and Sage, Robert A., "Stereoscopic Photography of Pathological Specimens," *Arch. Path.*, 19:684–686, May, 1935.

primarily becomes one of image size. The longer the focal length for a given distance the larger the image, and vice versa. Also, we find that as the focal length increases the angle of view decreases. Thus, we have a second factor to consider. Since, however, the two (point of view and angle of view) are both associated with focal length, we may consider them together.

Artists generally have adopted an angle of view of 40° or less. This adoption of a relatively narrow angle is in accordance with the phases of physiological optics referring to direct and indirect vision. It is known[8] that the macula lutea, or yellow spot, on the retina is the site of distinct vision, and that only as much of the subject matter as can be recorded upon this area will be in reasonably distinct vision. Because the angle subtended by the macula at the nodal point of the eye is very small (approximately 5°) most of the image falls upon the surrounding portions of the retina. Since this portion is much less sensitive to line and pattern, although very sensitive to light and color, only very general impressions of the image falling upon it are communicated to our mind. To examine the objects within the field of view, the eyes must wander from item to item, bringing each in turn into focus upon the macula. If the image-space contains many items, especially if these are of varying form and pattern, the view is likely to appear restless and confusing. Here again is an argument in favor of simplicity in composition and the exclusion of unnecessary and irrelevant objects. We are also free to assume that if we restrict the angle of view, the results will be far more satisfactory for scientific subjects by helping to concentrate attention where wanted.

Having demonstrated ample justification and precedence, we would like to urge the adoption of an angle of view of not more than 40°, not only for stereophotography but for all other types of scientific photography as well. In fact, in stereophotography a slightly narrower angle may well be adopted, since the combined areas covered by the lens in its two taking positions will somewhat exceed that of each, when considered separately. However, that is really splitting hairs, and so need not concern us at this time.

From what has been said before, it is apparent that the establishment of a definite maximum viewing angle also establishes the focal length of the lens, the one being dependent upon the other. The focal length giving a 40° viewing angle may be established with sufficient accuracy by simply multiplying the diagonal of the picture area to be accommodated by 1.38.

Because in all instances the focal lengths of the lenses are well in excess of the diagonal of the picture area, the perspective drawing will be found satisfactory and the image presented to the mind completely acceptable. This last

[8] Hall, Winfield S., "Text-book of Physiology."

statement, however, must be qualified by a statement with regard to viewing conditions. It is a law in stereoscopy that unless the taking and viewing conditions are geometrically harmonious, the image will suffer distortion. The subject of distortion has been ably discussed by Bolton[9] and should be thoroughly understood by all who wish to take stereoscopy seriously. It will be found that stereoscopy is an exacting science, demanding under penalty, absolute adherence to geometrical and optical principles if one would expect accurate orthoscopic rendering. At the same time it is one of the few processes where one may break nearly every rule and still not produce a total loss.

Though all of the above is true, we have no intention of preaching the doctrine of orthostereoscopy. We are rather inclined to agree in principle with Charles W. Wilman when he said that, "To insist on geometrically correct perspective in every case would be to confine stereoscopy to the optical laboratory." We have rather proceeded upon the premise that the average photographic laboratory is adequately served by a far less rigid treatment and that general principles rather than exact geometrical formulae will suffice. Those who have need for absolute orthoscopic rendering can do no better than to study a recent paper by Kurtz,[10] which contains a complete discussion of the subject.

Theoretically, the viewing of stereograms is governed by very definite rules, all of which are designed to reconstruct in viewing, the same geometrical conditions which existed in their making. Just as in photography the entrance pupil becomes the point of view which determined the perspective of the real images, so now the optical center of the stereoscope lenses becomes the viewpoint which determines the perspective of the virtual image seen through the stereoscope. This necessitates that the prints be so spaced when mounted, and the distance between them and the stereoscope lenses so adjusted as to maintain in viewing the original convergence angle. These conditions are satisfactorily met when the prints are mounted so that their optical centers are directly opposite the optical centers of the stereoscope lenses, and when the distance between the prints and the lenses equals the film to lens distance existing during exposure. The focal length of the stereoscope lenses should be approximately equal to the camera lens.

Could we look into the many photographic laboratories across the country, we should probably find a great many different types of stereoscopes in the possession of the photographer. Since it is to these instruments that our stereograms will be entrusted, it would appear to our advantage to know a little about some of the principal types.

[9] Bolton, Lyndon, "Stereoscopic Distortion," *Phot. J.*, XLIII, 4:107–118, 1903.
[10] Kurtz, Henry F., "Orthostereoscopy," *J. Opt. Soc. Am.*, 27:323, 1937.

The first stereoscope, invented in 1838 by Wheatstone, was of the reflecting type. Its modern progeny is found today in nearly every x-ray department and is excellent for use with large-size stereograms. The lenticular type of stereoscope was invented somewhat later by Sir David Brewster. This instrument has been referred to by some as a prism-type because of the fact that lens segments—halves and quarters of doubly convex lenses—were used in the place of whole lenses. There are perhaps very few of these stereoscopes in use today, but a close relative of it, designed by Oliver Wendell Holmes (1861), is still seen in many places, see figure 4a. Like the Brewster stereoscope, it too was fitted with lens segments. Doubly convex lenses are bisected through the

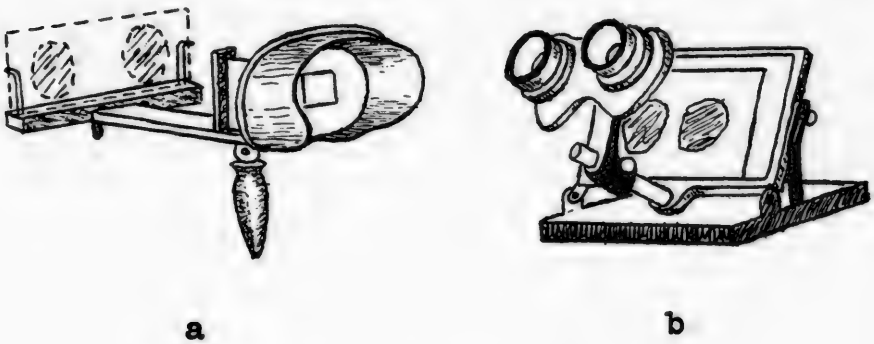

FIGURE 4.
a. Old style stereoscope.
b. Modern stereoscope (sketched from Weingart's paper).

center and again re-cut to form two square lens segments which were mounted as shown in figure 5. Although this instrument was very popular a generation or two ago, it has been replaced in a large part with stereoscopes of improved design. A distortion characteristic for instruments of this type is most evident with subjects presenting flat perpendicular surfaces. These are rendered slightly saucer-shaped with their concavity towards the observer. Because the optical centers of the segmented lenses lie at their outer extremes, as mounted in the stereoscope, the prints should be mounted so that their optical centers are equal to this interpupillary distance—approximately 80 mm.

Another form of lenticular stereoscope to meet with some popularity is the box type. Its design was occasioned by a demand for complete isolation of the stereoscopic image from all distracting influences—such as surface reflections or the intrusion of foreign objects seen beyond the physical boundaries of the stereograms. This much commends it to the devotee of stereoscopy, for noth-

ing is more annoying or detracts more from the reality of the image than such distraction. Its lack of general popularity is perhaps due to the fact that its construction is unfavorable to anything but transparencies. Oddly enough, this again should have been in its favor, because transparencies are always to be preferred to paper prints, having a far better scale of gradations and giving more luminous shadows.

The modern stereoscope of today is generally an open-frame type, fitted with large aperture, whole, well corrected lenses, see figure 4b. To some of these, extremely short focus lenses have been fitted, designed to correct distortion in the stereogram. An example of the latter type is the Zeiss Verant Stereoscope.

With a little perseverance and training, it is quite possible to successfully recompose the stereoscopic images without the use of a stereoscope. Brewster[11] describes the two methods for accomplishing this feat, referring to the eyes when used in this manner as an "ocular stereoscope." In his treatment of the subject he includes all necessary geometrical formulae and diagrams for each of the methods.

In short, one may recompose stereoscopic pictures, correctly mounted and oriented, by relaxing one's accommodation and looking "through the prints" to a point beyond the pictures. If the eyes are then, by the exercise of muscular power, gradually converged, the double images first observed will be seen to move towards each other until fusion is accomplished. The reconstructed stereoscopic image will then be seen in the center, flanked by an indistinct image on each side.

The second method requires that the right-eye print be mounted on the left side of the mount, and the left-eye print be mounted on the right side. If the visual axes are then crossed so that each eye views its own print, the reconstructed image appears at the intersection of the visual axes. To aid in crossing the visual axes, hold a finger vertically between the stereogram and the eyes. Fix your eyes on the finger and, with the print remaining stationary, slowly bring the finger closer towards the eyes. As with the first method, a center image will be seen to form between the original images. Slight additional adjustment will bring it into distinct focus—and third dimension. The trick of this method is to keep the eyes converged on the finger; and the disadvantage, that the prints must be mounted as explained above, making the mount unsuitable for viewing in the stereoscope. With each of these methods some training is necessary. However, beware of over-strain at the beginning, or severe headaches will result. It is best to begin with simple subjects on

[11] Brewster, Sir David, "The Stereoscope, Its History, Theory and Construction," p. 80 (1856).

small prints, mounted rather close together. They may be separated as experience is gained.

For those who find it difficult to focus the images, a little trick of ours may help. We do not know that it is entirely a new idea; however, it is original

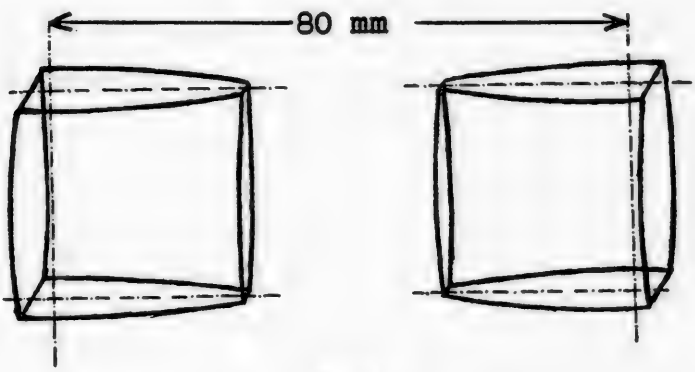

FIGURE 5.

Segmented lenses used in the older style stereoscopes.

with the author. If we take a pair of spectacles and hold them away from the eyes about two or three inches, and also place the stereogram, correctly oriented, at the principal focal distance of the lenses, the stereogram may be easily reconstructed. If the spectacles are fitted with convex meniscus lenses—i.e. positive concavo-convex lenses—it is easier to selectively present the proper print to its own eye if the spectacles are turned so that the concave side of the lenses faces the prints.

The photographic problems in stereography are much the same as those encountered in any other high class photographic endeavors and should receive as much consideration. The same factors which spell the difference between good and mediocre workmanship are equally pertinent here. With most of these problems the average reader is very well acquainted, and little need be said. However, there seems to be a misunderstanding amongst some on at least one point, and on one or two more some helpful hints may be extended. Therefore, we trust the reader will bear with us if we should appear a little elementary.

The question of lighting seems to have given rise to some confusion. We not infrequently hear the admonition to employ a flat lighting in stereoscopy and we cannot help but wonder why. Nature herself teaches us otherwise. When the sun is out and nature is in her most resplendent mood, she is also

the most revealing. The various objects show form and outline and are exhibited against a contrasting background. True, light alone is not responsible for all of this—color must also be credited. Somehow we are reminded of a thought we once read: "Light contrasts are the words of pictures."

So, let us use light judiciously. Let us employ a round, full lighting and not be too afraid of a few shadows. If they are well placed, they aid rather than detract in stereography.

Whenever it is possible, use a background which contrasts the subject, but preferably not a pure white or pure black. Transilluminated backgrounds are also generally to be avoided because they destroy the shadow effect. Use generous sized backgrounds and a picture area of such proportions that the eyes cannot see the borders of the prints when looking at them through the stereoscope. The object should not, however, occupy an angle of more than 30° to 35° within this area. In this way we more closely simulate the condition existing when looking at the object itself, and we avoid the feeling usually associated with stereoscopy, that of looking at the object through a window or aperture in the mount.

Give emphasis to your subjects by omitting all unrelated objects, but include a plain celluloid rule near the bottom of the picture area to aid in estimating object size.

All images should be needle sharp with no blurred or out-of-focus areas. This is simple when the object-lens distance is so large that the object is well within the depth of focus region of the lens; but not so when the object is small and requires that the lens be used very close to the object itself. Then it is not sufficient to simply "stop down" the aperture of the iris-diaphragm. It becomes vitally important that we know the range on either side of the sharply focused object plane possessing sufficient sharpness so that the object will appear to be in perfect focus. According to Prof. Conrady, this range is equal to

$$R = \frac{\text{f number} \times 2D(M+1)}{M^2}$$

where D = circle of confusion and M = magnification (scale of image).

Thus, photographing to full size (M = 1), using f:22 and a permissible circle of confusion of .01, we find

$$R = \frac{22 \times .02(2)}{1^2} = .88 \text{ in.}$$

Finally, do not immerse specimens under water or other liquids if you ex-

pect the most from your stereograms. The refraction caused by the light passing through two such dissimilar densities as air and water have a very shallowing effect on the specimen, resulting in a serious loss of third dimension. This is well worth remembering in other photography as well.

The recent great strides in color photography should be a challenge to all of us to attempt a few stereograms in natural color. For those who have not seen a stereoscopic picture in full and brilliant color, there is a real treat in store. Here truly is the perfect reproduction—correct drawing, third dimension, and natural color. How can we possibly wish for more?

BOOK REVIEW

PHOTOGRAPHY BY INFRARED. Walter Clark, Ph.D., F.I.C., F.R.P.S. John Wiley and Sons, Inc., New York. 397 pages, 101 illustrations; cloth, size 6 x 9½. Price $5.00.

This is an outstanding volume which encompasses a résumé of practically all that has been done up to the present time in the field of infrared photography. It is a work which is of inestimable value to those engaged in the biological sciences, in crime detection, in the scientific and practical industrial field of photography, and for those who are using these invisible rays for artistic photographic effects. The principles and applications of photography by infrared are discussed in detail in a rather simple manner while a very comprehensive bibliography terminates each chapter. Artificial sources of infrared are described in detail, as are the characteristics and sensitizing of photographic materials. Other chapters consider infrared photography as applied to the field of medicine, botany, paleontology, together with special applications. There are chapters devoted to a general and theoretical discussion of the penetration of radiation through the atmosphere, fog and haze. The author, who is an authority in the field of infrared, assumes that the reader has some acquaintance with the practice of ordinary photography. However, scientific knowledge is not necessary for the understanding of the practical applications presented in this timely publication.

RADIOGRAPHY, MEDICAL PHOTOGRAPHY OCCUPY WORLD'S FAIR EXHIBIT*

AN exhibit, designed to bring home to the general public the importance of radiography and photography in modern medical service, is one of the prominent features of the Exhibit Promenade in the Eastman Kodak Company Building at the New York World's Fair.

Leaving the spectacular exhibition of color photography in the Kodak Building's "Great Hall of Color," the visitor enters the Exhibit Promenade. A "Kodak World" exhibit faces the promenade entrance, and immediately to the right of this is the exhibit "Kodak in Medicine, Science, and Education."

Emphasis, in this exhibit, is placed on the importance of radiography in early discovery and diagnosis of disease, and on the value of photography in medical instruction and diagnosis, in educating the public on matters of health, and in preparing medical and research reports.

Large trans-illuminated radiographs, and transparency photographs, tell the story. A particularly dramatic feature, observed in looking back along the promenade, is a full-color, nearly lifesize screen projection of a daintily dressed young lady, which dissolves into a superimposed entire-body radiograph of the same subject as the visitor watches; then back again into the full-color original.

Closely associated with the medical exhibit is a display of scientific photography, including photomicrography, industrial radiography, astronomy, spectrographic analysis, photographic aspects of criminology, and similar applications. Another nearby display deals with Eastman organic chemicals, of which there are more than 3600 regularly supplied for research purposes.

Explanation of Plate

Intended to impress the general public with the importance of radiography and photography in modern medical practice, this exhibit is prominently placed in the Exhibit Promenade of the Eastman Kodak Company Building at the New York World's Fair. The screen at left displays a large-size, full-length full-color projection of a young lady, which dissolves dramatically into a superimposed radiograph. Note text adjoining. Panels at right tell the detailed story of radiography and photography in their applications to health education, medical instruction, and practice.

* Received for publication July 18, 1939. Eastman Kodak Company, Editorial Service Bureau, Rochester, N. Y.

KODAK IN HEALTH
RADIOGRAPHY
DIAGNOSIS & TEACHING IN MEDICINE
DENTISTRY
ALL THE BRILLIANT
CHIEVEMENTS OF THE
AST HALF-CENTURY, NONE
AS PROVED MORE VITAL TO
UMAN WELL-BEING THAN
H. DISCOVERY OF THE
K-RAY

PHOTOGRAPHIC TECHNIC

F. R. HARDING*

Photographs for Institutional Publicity

THE photographic department can be of invaluable assistance in raising funds for the institution, whether it is a school, hospital, or research laboratory, by producing good photographs for publicity purposes. To do this well requires a little study of what constitutes "appeal" in photographs.

Photographs of children made in the hospital wards, especially if the child is burdened with traction apparatus, braces, or bandages and still able to smile, have great value in loosening the purse strings of the public. The child does not have to be handsome, sometimes a freckle faced urchin with a wide and somewhat toothless grin will have more appeal than a pretty child.

Usually it is best to have the patient engaged in some activity, as this gives a point to the picture.

If new laboratories, etc., are to be photographed, have the workers performing their usual duties and photograph the scene with large flash lamps. Make some photographs of individuals at work. Remember that there should always be action!

Needed alterations within the buildings may be photographed so that the Board may see why alterations are necessary. Be certain to show *why* the change is needed.

There are many activities around the institution that will make good publicity photographs. Pictures of students at work in the various laboratories, nursing activities, special events, graduation exercises, new equipment being used, etc. None of these subjects are difficult to photograph with a camera equipped with a synchronized photo-flash attachment. In adult hospitals there are several clinics that may have worthwhile scenes for publicity purposes. Occupational therapy may be utilized for some excellent material, especially as it is not yet widely known by the general public. Remember that people are interested in other people, so try to include them in publicity photographs.

Talk over publicity with whoever has charge of such matters, and try to work out a long range program so that the photographic department will be notified when something will take place that has publicity value.

* Received for publication July 22, 1939. Children's Hospital, Boston, Mass.

Mount all publicity photographs in an album and number each print with the negative number assigned to it, so that prints will be ordered by number instead of description. This album should be kept in the office of the individual in charge of publicity. Confer with the department heads and try to get them to notify you when they have something that has publicity value. Always make these photographs, even though they may not appeal to you, otherwise a good publicity photograph may be missed at some other time. Most photographs for publicity purposes should be made in the form of close-up or semi close-up views. This is what most publicity men require.

Try to avoid flat lighting for this type of photograph. Employ plenty of side light so that there will be a good play of light and shade in the print. Reproductions of prints made in this manner stand out and are more clearly visible.

If the photographic department has never been called upon to furnish photographs for publicity purposes, why not make a few and submit them to the proper individual?

The writer employs a synchronized photo-flash on a Graflex camera for many publicity photographs. The flash attachment has a longer cord than is usual, so that the reflector and flash lamp may be disconnected from the camera and held in the hand about one and one half feet higher than the camera and off to the side. This produces somewhat better modelling, and eliminates the flat lighting which is so often seen in press photographs. A few photographs are made with a 5 x 7 view camera, employing either a photo flash lamp or one 1000 watt lamp for illumination.

Publicity photographs must be made rapidly or they will look posed. The best photographs for publicity purposes which have been made by the writer have been "candid shots" made without the knowledge of the subjects.

Twenty-Five Years of Leica Progress

In addition to marking the 100th anniversary of photography, this year also marks the 25th year of miniature photography, for it was in 1914 that Oskar Barnack produced the first Leica camera. While there were small film cameras before the Leica, it may be safely said that miniature photography had its birth with the Leica camera, for this type of photography has its basis, not on a small camera as such, but on a small camera of high precision and universality of application.

When Oskar Barnack joined the experimental staff of the Leitz Works in 1911, the concern was already famous for its pioneering and willingness to engage in costly experimental work in the field of microscope design and manu-

facture. Because of this attitude of the directors of the concern, Barnack, who produced his original model of the Leica in 1914, was able to go on with the experimental work and spend many years solving the basic problems and perfecting the instrument until it was ready for the market in 1925. In these years of experimental work lay the reasons why the basic design of the Leica never required any modification and why no model of the Leica ever becomes obsolete.

The decision to produce the Leica commercially was a momentous one in the photographic world, for not only did it represent a radical departure from conventional camera design but it required a costly investment in specialized tools and machines. From the start, however, the vast experience in optical and precision engineering of the Leitz Works was behind the camera. Never before in the manufacture of cameras had tolerances of less than 1/1000 of an inch been known. But these standards were set and maintained and soon the Leica was winning wide recognition because of its reliability and its constancy of quality.

Constant checking marks every stage of the manufacture of the Leica. Every individual piece produced by machine is submitted to stringent tests which reveal the slightest flaw. When a Leica leaves the factory, it has gone through so many tests, and has been checked and re-checked so often, that its performance may be relied upon without question. In a similar manner the same thing applies to the assembling and mounting of the lenses. Before Leica lenses are shipped, each one is tested photographically under the same conditions under which the photographer would use it. From all these tests, which insure maintenance of quality, one can see why the Leica camera rapidly won world-wide recognition as an instrument of highest precision, and why, today, more than 300,000 Leicas are in use throughout the world.

The character of the photographic market has been fundamentally changed by the Leica camera, not so much because it displaced older, large size cameras, but because it brought into being an entirely new camera manufacturing industry. Leica was the first camera to introduce the 24 x 36 mm. negative size, using 35 mm. film; the first to use a collapsible lens for compactness; the first to couple the film advance mechanism with the shutter rewinding mechanism; the first to apply a range finder to photography; the first to couple the range finder with the lens for automatic focusing; the first miniature camera to utilize interchangeable lenses; and the first to apply universality of operation to a camera by making available accessories to extend the scope of the instrument. In addition to this it enormously stimulated film and chemical manufacturers to devise newer and better products.

—E. Leitz, Inc.

New Minification Scale on Leitz "Nooky" Device

Photographers making close-up photographs of small objects have long used the Leica camera and the Optical Short Distance Focusing Device (familiarly known as the "Nooky") for this work since it permits the focusing range finder of the camera to be used. The device has always been a great convenience and time saver but now it has been made more convenient by the addition of a minification scale which permits the photographer to determine precisely the scale of reproduction of any object he may be photographing. The markings run from 1:6.5 to 1:17.5. Thus the photographer can determine in advance the size to which he wishes to make any reproduction. Since the range finder permits accurate focusing there is no need for setting the equipment by means of calibrations or using a ruler to measure the distance of the object from the film plane.

Full information on the Optical Short Distance Focusing Device may be obtained by writing to E. Leitz, Inc., 730 Fifth Avenue, New York City.

New Direct Focusing Finder Fits Filmo 141 Magazine Changer

Slipped into the Filmo 141 motion picture camera in place of the film magazine this new unit permits both precise visual focusing and accurate framing of any subject.

The image on the ground glass is upright and is magnified ten times so that no adjustment in magnifying power is needed for critical work. The focusing finder is particularly valuable for close-ups, small objects, titles, maps, and animated cartoons. Since the 141 camera may be reloaded while it is firmly mounted on a tripod it follows that the focusing finder may also be used without removing the camera from the tripod head.

Chemical Data Sheets

The Mallinckrodt Chemical Works of St. Louis, Mo., have prepared data sheets for some of their products which have considerable value for those individuals who wish to know more about the chemicals with which they work. The data sheets have on them the name of the chemical and its chemical formula, a description of its uses, storage, etc. At the present time sheets have been prepared for hypo, hydroquinone, sodium sulphite and Pictol.

CHATS WITH THE EDITOR

III. EVERYBODY TALKS AT ONCE

THE poor Author who has sat restively through the first two numbers of Volume Seven, now breaks his tether and hobbles into the conversation:

"May I ask," he asks, "is the Author then the only one of the medical journal triad who doesn't know a thing about it?"

Editor and Photographer with one voice, "Well, practically. What have *you* to contribute?"

Author: "After all, I'm the man with the idea. Without me you would both go to the wall."

Editor and Photographer, with one gulp, keep silence.

Author: (gaining confidence) "I can take my own pictures. What's the matter with these?"

And so the Photographer ungulps and begins:

"This one is on rough paper, which will produce a harsh effect, and gray out the blacks in the reproduction.

"This one is a trifle out of focus. Only slightly, but enough to spoil a page in the journal.

"This one has no brilliance, wherefore the wound is lost in the draperies.

"These two of the new gadget are no doubt intended to appear side by side on the page, yet the first is printed twice as dark as the second.

"This one—"

Author: "Enough. It seems I'm not the photographer I thought I was, though that shot I made with the Brownie in Yellowstone back in '31 took a prize at the Tuesday Club exhibit. And the six color films I sent you last winter were perfect. Why didn't you print those?"

Editor: "Just a matter of a couple of thousand dollars. Three- or four-color processes require a copper plate for each color, each in perfect register with the others, and etched to just the proper depth to blend without dominating the whole. These plates are very expensive. On top of that, the paper on which they are printed must be of a very high grade, sometimes requiring an inserted

page. Beside that the sheet must go through the presses once for each color, and the presses have to be cleaned each time, and the plates justified to within a thousandth—"

By this time the Author was sobbing noisily.

Editor: "In this country only the journals with very large circulation can afford color. Even half-tone plates are expensive, and most medical journals run on a narrow margin. Editors must keep the cost down. If an author sends in twenty prints, most of them must go. Authors can delete with much better judgment than editors, and should do so. Further, the twenty illustrations which, on the screen, embellished the presentation, may utterly overwhelm it in a journal.

"Fine print, which may be very clearly reproduced through a zinc etching, may be quite illegible in a half-tone reproduction. Therefore, where fine print is to be reproduced, one must not introduce into the illustration material which calls for half-tone work. For example, I recently examined a large series of the most beautiful hearing charts (audiograms). The author had labored over them for hours. Alas, the curves were in four colors. They could not be reproduced in black and white, because, the only distinction between them was their color. To add to the difficulty, a beautiful half-tone wash drawing of the ear drum was mounted upon each one—smack in the center. Of course, these graphs *could* have been rendered exactly as they were, but it would have bankrupt the journal. There were thirty-seven of them!

"Done in black lines dotted, dashed or solid to distinguish them, with a line drawing of the ear drum in the same black ink, they would have been equally informative, and would have cost around sixty-five dollars."

By this time the Photographer also was crying into his hypo, and the Editor let it go at that.

* * * * *

I told you in the beginning that this was a fairy tale, and to end it on a tragic note seems mildly unorthodox, but you can't have these three fellows marrying one another and living happily ever after, because what with the present state of the country, and all that, who can? And so, I too will callously let it go at that, allowing the chips to fall where they list. When you hear the gong . . . etc. etc. etc.

ARTHUR W. PROETZ, M.D.
Editor, *Annals of Otology, Rhinology, and Laryngology.*

CURRENT PHOTOGRAPHIC ABSTRACTS

0673

Film Wear. D. C. Ottley. *Amat. Phot.*, **85**: 504, May 4, 1938. Methods of reducing deterioration and mechanical wear of motion picture film are briefly outlined. Mechanical wear may be reduced to a minimum by keeping the projector gate scrupulously clean. Skidding of the coils during winding should be avoided, and rewinding tightly before storing is recommended. The films should be stored at a low, even temperature in humidor cans, and treated with stock disinfectant; they should be taken out at least once every six months, inspected for traces of mold, cleaned if necessary, and respooled. Any deposit of oil on the film caused by excessive lubrication of the projector should be wiped off immediately after projection in order to prevent the oil from collecting dust. T. M. L.

374–06313

Light Control in Photography. G. Mili. *J. Soc. Mot. Pict. Eng.*, **30**: 388–99, April, 1938. The principles underlying light control by means of various types of reflectors and lenses for the attainment of proper light-modeling in photography are formulated. The basic units that may be employed are discussed with particular reference to their performance, advantages, and limitations. (Author's Abstract)

X0609

Cineradiography by the Indirect Method. R. Reynolds. *Radiology*, **31**: 177–82, August, 1938. After a historical discussion of the subject, the author describes the essential features of his method, which include a high-powered x-ray apparatus, a brilliant fluorescent screen, a fast lens (f/0.85), specially selected film (16 mm.), and a special synchronizing switch for energizing the x-ray generator only during each exposure period of the camera cycle. R. B. W.

X0609

Direct Radiocinematography. Van de Maele. *Radiology*, **30**: 750–55, June, 1938. The first apparatus, taking pictures 120 mm. by 140 mm., on a continuous band of film, was based upon the principle of the ordinary motion-picture machine, with intermittent motions by a Maltese cross. A new model utilizes cut-sheet films which are shifted into and out of exposure position by means of a rotating drum. The films are exposed between intensifying screens. A rapidly rotating Bucky grid removes most of the scattered radiation arising in the subject. R. B. W.

J9–L6–L1

High Gloss and High-Gloss Retouching. B. Jann. *Fot. Rund.*, **75**:284–85, No. 16, 1938. Mirror glass cleaned with nitric acid and then soap and water is suggested for drying prints cold; chrome sheets are suggested for the heat press. A high-gloss solution, containing 5 c.c. each of oxgall and formalin per liter. When retouching, the gloss is first removed with moisture, and after the work has been finished, the prints are soaked and reglazed. R.W.H.

089–06

Photography and Cinematography of the Emission of Perfume by Flowers. H. Devaux. *Bull. soc. franc. phot.*, **25**:109–11, July, 1938. The phenomenon of a piece of camphor moving about on a water surface because of unequal surface tension on various sides of the particle is well known. This principle has been applied to make visible and photographable the emission of perfume by flowers. A mercury surface is commonly employed, sprinkled with an impalpable powder like lycopodium or talc, and a flower petal attached to a tiny sheet of glass is placed on the surface. The resultant motion can be photographed with a still or motion picture camera and the degree of agitation manifest is roughly a measure of the rate of emission of the perfume. H.A.M.

097–098

An Apparatus to Assist in Photographing Experimental Material. L. H. Addington. *Science*, **88**:335–36, Oct. 7, 1938. An apparatus is described for photographing small animals, such as rats, which consists of a boxlike arrangement with an opening at one end for inserting a camera, and a hinged door at the opposite end for inserting the specimens to be photographed. A lamp recess is located on each side of the box. A 15-cm. rule for indicating comparative sizes, and a white card with sufficient data to identify the specimen, the date, and the number of the particular photograph are attached to the door. The dimensions given by the author were designed to accommodate an Eastman Six-620 camera with a portrait attachment. Using supersensitive panchromatic film, satisfactory photographs were secured with the lens set 30 inches from the back wall, a 1/25th-second exposure, an aperture of f/16, and the apparatus set five feet from the animal. The photographs of the animals are about 14 per cent of natural size and, when enlarged 3½ times, are one-half natural size. The dimensions may readily be adapted to other makes of cameras. K.G.

21

This Year's New Cameras. *Phot. Dealer*, **52**:222–25, June, 1938. Tabloid reviews of new and improved cameras announced since January, 1938 give brief particulars and prices. T.M.L.

Selected by permission of the Eastman Kodak Company from the Monthly Abstract Bulletin of the Kodak Research Laboratories.

ASSOCIATION NEWS

Preliminary Program for the Eighth Annual Convention, B.P.A.

Mellon Institute for Industrial Research, Pittsburgh, Pa.
Headquarters: Webster Hall Hotel

Thursday, September 14, 1939.

A.M.

9.00 Registration.

10.00 President's Address.
Louis Schmidt, Rockefeller Institute for Medical Research, New York, N. Y.

10.30 "Print Quality."
Lloyd Varden, Agfa Ansco Corp., Binghamton, N. Y.

11.00 The Scientific Photographic Department.
Ralph Creer, Veterans' Facility, Hines, Illinois, will preside. Room arrangement, equipment requirements, etc. will be presented informally by several members. Dr. Earle Perkins will describe the Department of Biophotography, Rutgers University, New Brunswick, N. J. Questions and informal discussion invited.

Recess.

P.M.

2.00 Special session of guest speakers on the uses of scientific photography:
Robert Cook, Editor of the Journal of Heredity, Washington, D. C.
Watson Davis, Director of Science Service, Washington, D. C.
David Dietz, Lecturer in General Science, Western Reserve University, Cleveland, Ohio.
Captain John Bradley, Chief of the Division of Motion Pictures and Sound Recordings, The National Archives, Washington, D. C.

8.30 Projection of motion pictures and slides at the Mellon Institute. Informal.

Friday, September 15, 1939.

A.M.

9.30 Seven-Minute Sessions.

Short, complete, practical papers describing individual technics. The following are probable subjects:

"Photomicrography of Blood," Stella Zimmer, College of Medicine, Syracuse University, Syracuse, N. Y.

"Photography of Posture and Scoliosis," F. Harding, Children's Hospital, Boston, Mass.

"Kodachrome Enlargements in Black-and-White," A. Levin, Montefiore Hospital, Pittsburgh, Pa.

"Miniature Color-Photography of Skin Lesions," C. Henry, Falk Clinic, Pittsburgh, Pa.

"Cervix Photography," W. Payne, New York State Institute for the Study of Malignant Disease, Buffalo, N. Y.

Time will be allotted for discussion after each paper. Louis Schmidt will preside.

11.15 Business Meeting.

Recess.

P.M.

2.30 Surgical and Clinical Photography.

Leonard Julin, Mayo Clinic, Rochester, Minn., will preside over a session of short papers in which the following topics will be presented:

"Photography in the Study of the Eye," C. F. Kutscher, M.D., Medical Arts Building, Pittsburgh, Pa.

"Editing Surgical Films," Leonard Julin.

"Photography of Neurosurgical Operations with the Mirror Technique," H. S. Hayden, Montreal Neurological Institute, Canada.

"Photography of the Larynx," a film prepared by J. Pressman, M.D., and Arthur Hinman, Los Angeles, Cal.

"X-Ray Motion Pictures," a review of the films achieved thus far. Adrian Ter Louw, Eastman Kodak Company, Rochester, N. Y.

7.30 Banquet at the Webster Hall Hotel. Formal or informal dress.

Saturday, September 16, 1939.

A.M.

9.30 Tour of the Mellon Institute.

10.30 Photography with the Microscope.

Leo Massopust, School of Medicine, Marquette University, Milwaukee, Wis., will preside. The following topics will be discussed:

"The Sensible Use of Numerical Aperture," L. V. Foster, Bausch & Lomb Optical Co., Rochester, N. Y.

"Kodachrome Photomicrography with Carbon Arc Illumination," Leo Massopust.

"Kodachrome Photomicrography with Transmitted and Reflected Light," H. W. Zieler, Leitz Co. Illustrated with pictures by Mr. Baumann of the same company.

Discussion of the Photomicrographic Competition.

Recess.

P.M.

2.30 "The March of Photography."

The year's advances in lenses, emulsions, illuminants, etc. Representatives will be present from the Agfa Ansco Corp., Bausch & Lomb Optical Co., Eastman Kodak Co., Leitz Co., Spencer Lens Co., and we hope from Bell & Howell, Dufaycolor, Folmer Graflex, Defender, General Electric and possibly others. General discussion. Melvin Dillman, M.D., Jefferson Hospital, Philadelphia, Pa., will preside.

NOTE: MEETINGS WILL BEGIN PROMPTLY.

A projection room will be available at the Webster Hall Hotel throughout the Convention for those who have films and slides of interest to special groups.

This program was prepared early and may be changed. Copies of the final program may be had any time after September first from Miss Anne Shiras, Magee Hospital, University Office, Pittsburgh, Pa.

Regional Committee

Plans for this year's Convention were the product of a Pittsburgh Committee, a Regional Committee, and individual members who sent in suggestions. Those suggestions which could not be acted upon this year were placed in the 1940 file and will be further discussed for the next meeting.

The Regional Committee was an experiment. It was formed on the theory that a more balanced program could be achieved if members in scattered parts of the country suggested material for papers and Salon exhibits. It was to be a sort of Correspondence Committee—and it really corresponded! The letters from these members were so interesting that the Association should consider establishing such a group permanently. The following were the Regional Members:

J. A. Carlile, Rockefeller Institute for Plant Research, Princeton, N. J.
Ferdinand Harding, Children's Hospital, Boston, Mass.
E. M. Hart, University Hospital, Cleveland, Ohio.
H. S. Hayden, Montreal Neurological Institute, Canada.
Arthur Hinman, Good Samaritan Hospital, Los Angeles, Cal.
Leonard Julin, Mayo Clinic, Rochester, Minn.
Adolph Marfaing, Columbia Institute of Ophthalmology, New York, N. Y.
William Martinsen, Municipal Sanitarium, Chicago, Ill.
Frank Ruslander, Harper Hospital, Detroit, Mich.
Robert Sage, Baylor University, Dallas, Texas.

Wanted—Some Information

Have you had any experience with photography through the gastroscope, or peritoneoscope? If not do you know anyone who has? Inquiries are coming in about technics in these fields and we would like to accumulate some data for our files.

Here and There

Photography of the larynx and vocal cords seems to have taken a sudden leap. A number of photographers, writing for information about the Association, state that they are particularly interested in this subject. Among our members, F. W. Kent, university photographer in Iowa City, has been making color-movies of the larynx and cords, and reports that they are very successful.

Arthur Hinman, of the Good Samaritan Hospital, Los Angeles, Cal., has made several color-studies and also reports success with slow-motion pictures, in black-and-white at eight times normal speed.

The first prize for exhibits at the New York State Medical meeting went to Syracuse University's photographs of Basophilic Leukemia. These were made by Stella Zimmer, Treasurer of the B.P.A.

Wilbour C. Lown, photographer of the Massachusetts General Hospital in Boston, Massachusetts, had a moving picture to make which included shots of a long moving tracing or graph. He solved the problem ingeniously by means of a Kodascope projector connected to a soft wood roller and a rewind gear. In spite of the fact that his department is a busy place, Mr. Lown took time out to photograph his set-up and send us a print with a brief description. Now if any other photographers encounter the same problem we are in a position to save them some time. (This is not only a news item. It is a hint. Please take notice and send us descriptions of your set-ups. If they do the job they are worth passing on.)

A list of recent films and new work undertaken by our members, as described on their renewal cards, will be published in a later issue.

Visual Education

Early this summer Mr. William Kruse of the Bell and Howell Co., Chicago, Illinois, sent out a circular which began: "Your interest in education through the use of motion pictures is a fortunate one. Right now this subject is the one of most active general interest in the whole school field." There followed a list of no less than eighty-eight meetings and courses in visual education to be held this summer. Those who are interested in the rapidly growing field of visual instruction will find Mr. Kruse's list useful for reference.

New Members

We welcome the following new members to the Association:

Paul Anderson, 43 West 66th Street, New York, N. Y.

Sister M. Beatrice, St. Mary's Hospital, Waterbury, Conn. (*Ralph Creer*)******

Eustace L. Benjamin, M.D., Evanston Hospital, Evanston, Ill.

William R. Duryee, New York University, Washington Square College, New York, N. Y. (*Dr. O. W. Richards*)***

Miss Avis Gregersen, 303 East Chicago Avenue, Chicago, Ill. (*Dr. T. Benedek*)
Charles M. Hayes, Ayerst, McKenna & Harrison, Montreal, Canada (*N. S. Horton*)
Lloyd G. Henbest, U.S. Geological Survey, Washington, D. C.
William H. W. Komp, U.S. Public Health Service, Ancon, Canal Zone (*Louis Schmidt*)****
E. B. Mains, Museum Building, University of Michigan, Ann Arbor, Mich.
Hinton F. Miller, Mason City Hospital, Mason City, Washington
Donald D. Potter, P. O. Box 482, Vancouver, Wash. (*Ralph Creer*)*******
John L. Stephens, Callaway Hospital, Fulton, Mo. (*Margaret Brown*)

Asterisks denote the number of new members brought in by each sponsoring member who has brought in more than one.

The B.P.A. wishes to thank Dr. Arthur Proetz of St. Louis, Mo., and Dr. George Semken of New York, N. Y., for their recent renewals as Sustaining Members. These memberships are of real value in supporting our activities, one such member being the fiscal equivalent of eight regular members!

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UNIV. OF MICH.

The Journal of the
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Association

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SOME FACTORS IN OBTAINING OPTIMUM PRINT QUALITY*

LLOYD E. VARDEN†

UNDER the heading "print quality" are generally grouped those factors upon which not only the subjective interest of a picture, but also its documentary value are dependent. However, it cannot be assumed that pictures which are said to possess good print quality, necessarily evoke a high visual appeal. The quality of a print, as defined photographically, simply embodies the elements of perfected workmanship and although these elements are often in some undefined manner related to the aesthetic quality of a picture, they are not in themselves responsible for any picture's pictorial success. For example, a given scene can be photographed both at night and during the day, with a great possibility that one of the pictures will be vastly superior to the other from a pictorial standpoint. Yet, from a photographic standpoint the scale of tones within the range of the paper (although the same for each scene) will be able to depict an equally good impression of either the day or night scene merely by a different arrangement of the tonal masses. In other words, each print can easily have the same general print quality, and still differ substantially in pictorial merit.

*Presented at the convention of the Biological Photographic Association, Pittsburgh, Pa., September 14, 1939.
†Agfa Ansco Corporation, Binghamton, N. Y.

EXPLANATION OF FIGURES

Figure 1 and 2. Two prints showing how print quality is improved by very meticulous adjustment of paper exposure scale and negative density contrast. Figure 1, although acceptable, has not been made on paper which fits the negative as perfectly as that used in figure 2.

However, from the biologists' standpoint "print quality" concerns mostly the documentary value of a picture; that is, its value as a record. Does the picture truly depict the subect — in tone separation, in image detail, perspective, and so on? Will the print retain its original character after storage? These are the questions which in this case must be answered in order to determine whether or not optimum print quality has been attained.

It would be futile to attempt to consider all of the contributing factors, but we can touch upon some of the more important ones if we begin by assuming that the necessary pre-requisite characteristics have been arrived at in the negatives used.

Beginning, then, toward the attainment of optimum print quality from a given selection of negatives we would first group them according to contrast by critical visual examination. This is usually done by judgment of the over-all density range, but many instances arise in which it is evident that the most important area of the negative has a density range which in itself is opposed to the general character of the negative. We can refer to these local areas as having local density contrasts whereas the entire negative contrast may be called the gross density contrast.

In many cases there is a regular and smooth transition of densities in the negative, making it necessary for one to consider only the gross density contrast in the printing procedure. It becomes a considerably more difficult problem when the negative consists of various areas of equal importance but of different contrast character. However, one is usually able to judge the relative importance of different negative areas and is able to select the most suitable paper grade accordingly. In general, the rule may be accepted that the most important range of tones in the negative to be reproduced in the positive paper print, must have a transmission range corresponding to the exposure scale of the paper.

The exposure scale of the various grades of three commercially available papers are:

CONVIRA	BROVIRA		CYKORA
0 — 1-128	Soft	— 1-100	1 — 1-90
1 — 1-90	Medium	— 1-50	2 — 1-45
2 — 1-65	Hard	— 1-20	3 — 1-30
3 — 1-30	X-Hard	— 1-10	
4 — 1-20			
5 — 1-15			

These exposure scales simply refer to the exposure ranges which are required for the paper in question to produce the maximum tone

separation of which it is capable. Therefore, in printing negatives of great transmission range, papers with high exposure scales should be employed, and so on. This factor, although of a very basic nature, is not given altogether too much consideration in practice.

A practical method for finding the transmission range of a negative by use of a new photoelectric cell instrument has been described in the July, 1939, issue of the Journal of the Photographic Society of America, now making paper exposure scale data more useful.

It has been proposed from time to time to make use of a two tray developing procedure for the purpose of correcting some of the difficulties introduced when negatives have different, but equally important, local and gross contrasts. In one tray is placed a very soft working developer, usually a straight metol type, and in the second is placed a developer capable of rendering full contrast. By placing a print for proper periods in the two developers it is supposed to be possible to produce a full scale of tones in the print (within limits) without sacrificing good blacks and brilliance. Two companion formulas for this purpose are given below:

AGFA 120
SOFT-WORKING PAPER DEVELOPER

This is a soft-working developer, primarily intended where soft gradation is required.

Stock Solution

	Metric	*Avoirdupois*
Hot Water (125° F. or 52° C.)	750 cc.	24 ounces
Agfa Metol	12.3 grams	¼ oz. 70 gr.
Agfa Sodium Sulphite, anhydrous	36 grams	1 oz. 88 gr.
Agfa Sodium Carbonate, monohydrated	36 grams	1 oz. 88 gr.
Agfa Potassium Bromide	1.8 grams	27 grains
Water to make	1 liter	32 ounces

For use, dilute 1 part stock solution with 2 parts water.
Normal developing time, 1½ to 3 minutes at 70° F. (21° C.).

AGFA 130
UNIVERSAL PAPER DEVELOPER

This formula is a universal developer for all projection and contact papers. It gives rich black tones with excellent brilliance and detail. Agfa 130 provides unusual latitude in development and is clean-working even with long developing times.

Stock Solution

	Metric	*Avoirdupois*
Hot Water (125° F. or 52° C.)	750 cc.	24 ounces
Agfa Metol	2.2 grams	32 grains
Agfa Sodium Sulphite, anhydrous	50 grams	1¾ ounces
Agfa Hydroquinone	11 grams	¼ oz. 50 gr.
Agfa Sodium Carbonate, monohydrated	78 grams	2½ ounces
Agfa Potassium Bromide	5.5 grams	80 grains
Agfa Glycin	11 grams	¼ oz. 50 gr.
Water to make	1 liter	32 ounces

The prepared stock solution is clear but slightly colored. The coloration in this case does not indicate the developer has deteriorated or is unfit for use.

For use dilute 1 part stock solution with 1 part water.

Normal developing time as 70° F. (21° C.) for Brovira, 2 to 6 minutes; for Convira and Indiatone, 1½ to 3 minutes.

Greater contrast can be obtained by using the developer stock solution full strength. Softer results can be obtained by diluting 1 part stock solution with 2 parts water.

Formula 120 builds up detail rapidly in the highlights but the shadow densities do not become very vigorous except on prolonged development. If the print is placed in formula 130 after sufficient highlight details has developed the shadows will then come up to their full strength.

But regardless of the care taken in adapting the negative transmission range to the exposure scale of the paper, unless the paper itself possesses proper gradation characteristics a faulty reproduction will result. Where it is required to have detail separation throughout the density range of the paper, a paper possessing approximately a linear density-exposure response should be chosen. A paper having a perfect linear density increase with exposure does not exist, but certain papers do give a smoother progression of density increase than others, and by means of a step wedge these papers may be sorted out by simple experiment.

The determination of the proper paper does not terminate the requirements for producing optimum print quality. It is also necessary that the apparatus used for making the print fulfil certain conditions.

Figure 3. Print from a well-exposed and developed negative having a smooth progression of densities throughout its scale. See text.

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These conditions, although also of a fundamental nature often mean the difference between superior and inferior results. For example, in contact printing, very fine but important details are easily merged together from lack of proper contact between paper and negative. In printing negatives of a scientific character the maximum sharpness is desired. As a matter of fact, for very critical work it is best to use a point light source at least six feet from a printing frame. By using nearly parallel rays acquired in this manner, a marked improvement in sharpness is often observed.

This factor also applies to the making of projection prints, however, in this case the problem is somewhat more complex. Very critical focusing should be obtained, but in addition the lens system should create a minimum of scatter. Small negatives should be masked in order to prevent extraneous light from flattening the image. The lens should be entirely free from contamination, since a slight film over any of the glass surfaces is sufficient to cause considerable loss in sharpness, brilliance, and tone separation.

Needless to say, in the printing of a negative the proper exposure must be given the paper. This is easily determined if care is taken to standardize on a developing procedure known to be suitable for the paper in use. A standard developer held at approximately 70° F. used for the recommended time will assure consistent results. Too often development is conducted on the basis of over-all density, irrespective of the exposure and development times. This practice almost always produces prints of poor gradation and color.

The usual precautions against over-working a developer must be observed. A type print can be kept at hand for comparison against prints produced by a developer thought to be approaching the exhaustion point. When the color of the prints become muddy or when the developer itself becomes discolored, exhaustion is definitely indicated. In cases where a relatively fresh developer gives prints of poor color the answer usually lies in the contamination of the developer by the hypo solution carried over by the hands. Dr. Weyde of the Agfa Research Laboratories has recently found that with many papers exceedingly small amounts of hypo cause a distinct degradation of print color.

It is also advisable to conduct periodic checks on the darkroom illumination in order to eliminate the possibilities of fog. Modern type papers often have extended wavelength sensitivity, making them less safe under light conditions which formerly proved satisfactory. Recently orange-red fluorescent tubes have been successfully used for printing rooms, giving a high luminous intensity but yet safe light for handling all types of papers.

Another cause for coloration of print tones, especially on glossy prints which are dried on heated glossing drums, arises from leaving prints too long in the acetic acid short stop bath. This is also exaggerated by having the short stop bath too strong. In other words, the common practice of pouring an unknown quantity of acetic acid into a tray of water for use as a short stop and allowing prints to remain longer than a few minutes, is a possible source of trouble and is not to be recommended.

The washing procedure seldom causes any visible changes in the quality of photographic prints. However, from a standpoint of permanence this is an all important step. In general, photographic departments have allowed the washing procedure to become regarded as a waste of time and water. Many departments have standardized on a 15 minute wash period for prints, which is definitely insufficient to assure permanence. An hour of washing, by an efficient system is still to be highly recommended. In some special cases a bath of 1 per cent Sodium Carbonate solution may be used for one minute previous to washing, which would reduce the washing period to 30 minutes or slightly less. For a number of reasons, however, this procedure cannot be recommended generally.

Finally, there are certain aspects of the drying of photographic prints which must be considered in order to affect optimum print quality. Drying conditions should not promote more than a normal amount of curl or deformation of the paper stock. Hot gloss driers or excessive drying of matte prints in too dry an atmosphere are likely to result in not only a permanent deformation of the paper but also in a change of the appearance and in particular the color of the prints.

If all these precautions are taken optimum print quality will not be difficult to realize.

A SUSPENDED PHOTOMICROGRAPHIC CAMERA

WILLARD S. HASTINGS, M.D.*

AMONG the features sought in a photomicrographic camera are rigidity, freedom from vibration, stability of equilibrium, an adequate range of bellows extension, convenience of focusing and of moving the specimen, and ease in the use of accessories. Under some circumstances floor space becomes a deciding factor. At the time the installation of some equipment for this purpose was contemplated a few years ago, the writer had long entertained the idea that stable equilibrium and freedom from vibration could best be combined by suspending the camera from some overhead cushioning device, with the optical axis running vertically. This would not only provide greatly improved equilibrium, but would use much less floor space and keep the microscope stage in a horizontal plane. The latter is essential for some wet mounts and is always a convenience in handling slides. Since none of the stands on the market known to us embodied all of these features, it was decided to build one.

The accompanying drawings illustrate the main features of the camera. It is essentially a strong steel frame which is suspended by four long bolts from a wooden plate which rests upon a partially inflated rubber "invalid ring." This is supported by a wooden platform (C) which is held up by corner posts and attachment to a wall. Obviously a step-ladder or similar support would be necessary and other difficulties encountered if the ground-glass had to be viewed in the position of the plate when a long bellows extension is in use, therefore, reflex focusing was decided upon. Few of the reflex cameras on the market provide adequate clearances or sufficiently large mirrors for the eye-piece-to-plate distance which we wished to be able to employ. Hence we had the camera box (D) built and fitted to our specifications. It is 9 x 10 x 9 inches in size and provides for a 5 x 7 inch plate-holder. Clearances must be adequate to prevent reflections from the side-walls, and all edges must be beveled to reduce such reflections. Surfaces which cannot be kept out of the light path, e.g. the back of the mirror, are covered with black velvet. The mirror is silvered on the first surface. It is mounted on a swinging brass plate that is covered on all other surfaces with velvet and has turned edges that fit into a brass channel when the

* Received for publication July 24, 1939. Jeanes Hospital, Philadelphia, Pa.

mirror is in the vertical position. When in the 45° position, it fits light-tight against an inner frame which can be adjusted in position. The ground-glass for focusing in the front of the box is likewise in a thin wooden frame which can be moved in or out to bring it into exact register with a ground-glass in the position of the plate. It is held by set-screws and, once in correct position, neither it nor the frame holding the mirror need be moved. The plate-holder fits in a grooved space on the top of the box beneath a hinged frame, which is fitted with contact springs and is itself held open by a spring when released from its catch.

The frame which serves as an optical bed was constructed from four steel bars (E) measuring 2 x ½ inches on section and 6 feet in length. These were bolted securely to ¼ inch steel plates at top and bottom. They were first trued on all edges and surfaces and finally were chromium-plated, satin finish. The bars on the left side of the observer have a free space of 6 inches between them to allow for the withdrawal of the dark slides of the plate-holders, and for the lamp. Those on the right side are ¾ inch apart, since this narrow slide-way is less apt to jam, and more free space is provided around the microscope.

A heavy wooden shelf (F) was screwed securely to the side bars for the support of the microscope, and to add to the rigidity of the frame. Resistance to torsional strains was provided by braces at the top, which have been omitted from the drawing to avoid confusion. The frame is fairly heavy and we have never observed a shift of the image during exposure, but to be doubly sure we have made it a rule to arrest all swing of the frame before making an exposure. It is possible that an optical track formed of a single bar containing an equal weight of metal would be less subject to tortional deformity than the frame, but it has been felt that the symmetrical construction employed has had compensating value in smoother operation and lessened strains on the bearings and attachments of the parts.

Several pairs of brackets were made to slide smoothly between the side-bars and clamp by externally placed thumb-screws. One pair supports the camera box, another the shutter, and another the lamp and lower mirror. Still another is available for accessory lenses. The wooden plate carrying the lower end of the bellows and the light-tight connection with the microscope has a special bracket with felt-faced sliding-surfaces and a spring interposed in the clamp, so that it can be slid up and down without change of the screws.

The weight of the camera box is counterbalanced by means of three small cables made of a rust-proof alloy, which pass over pulleys to a grooved drum 4 inches in diameter and from this, over pulleys attached to the top of the frame, to a single weight, to which they are

connected by compensating pulleys. A circular aluminum plate 9 inches in diameter is attached to the drum and serves as a handle by which the camera box may be moved smoothly and precisely, though it is usually handled by the thumb screws on the clamps. A scale is cemented to one of the uprights, with a pointer on the bracket reading directly the distance from eye-piece to plate.

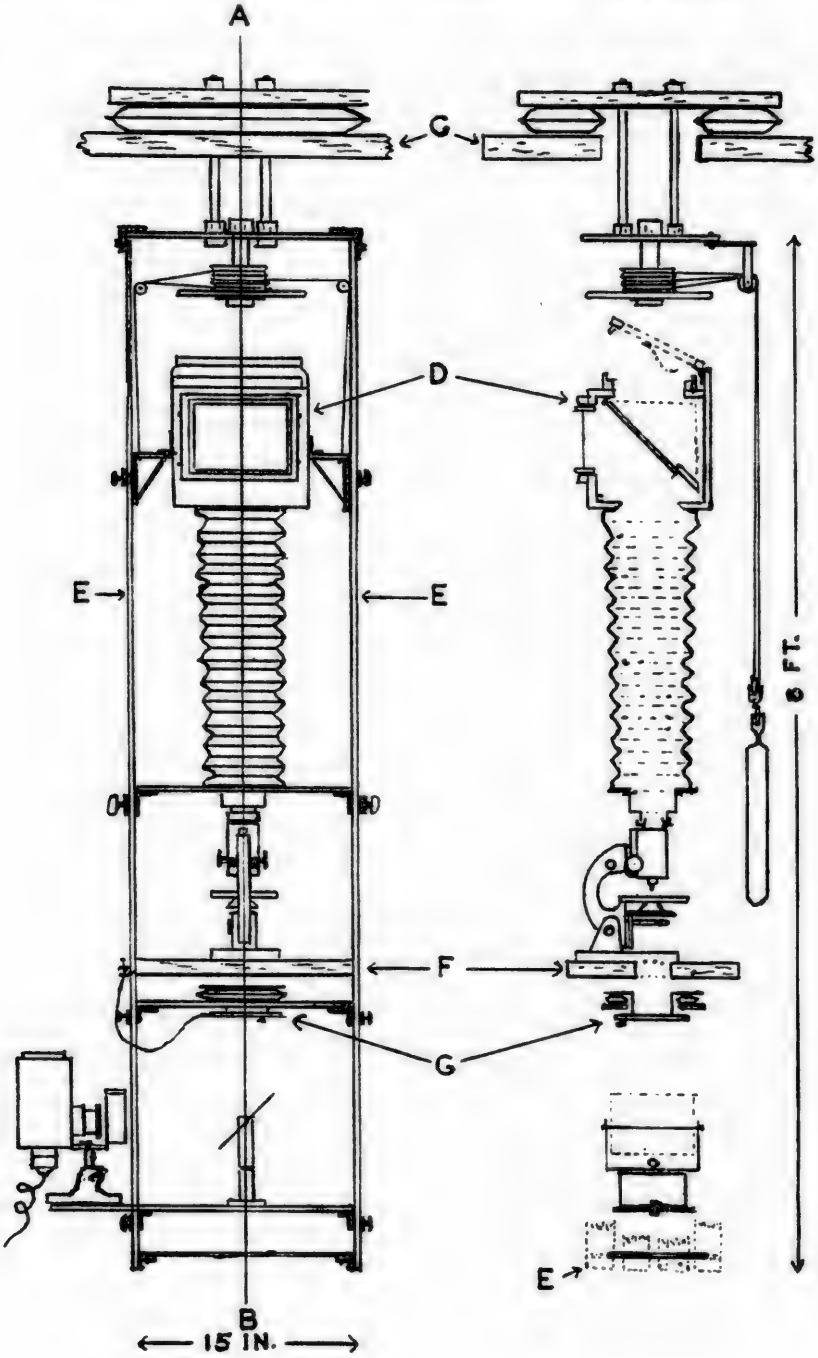
The shutter (G) is mounted beneath the shelf that supports the microscope. If the camera were left for prolonged periods with the dark slide withdrawn, there might be some fog from strong light entering the objective, with the shutter in this position. No trouble has been experienced, however, possibly in part because a black curtain is hung around the apparatus to facilitate focusing. The shutter is suspended by a wide tube from a metal plate resting on a small inflated rubber ring. This in turn lies on a movable shelf which is supported without metallic contact with the frame. These precautions were taken to permit repeated "snap" exposures without setting up vibration in the frame.

Owing to the blackening of all forms of tungsten bulbs and the flaming of arcs, it proved impracticable to mount the lamp in the optical axis. A mirror is therefore used, and the light reflected into the optical axis from the lamp. The latter contains a ribbon-filament bulb and is fitted with a corrected condenser, an iris diaphragm, and a water cell. Since this diaphragm is used as a field-stop and is projected into the plane of the object, filters with their possible finger-marks and other imperfections are not used at the lamp, but are placed over the opening in the shelf supporting the microscope below the substage diaphragm. The mirror used with the lamp need not be silvered on the first surface. It should be pivoted, as illustrated, in a line across its center which intersects the optical axis at a right angle.

An "invalid ring" 17 inches in diameter is used in the suspension for absorption of vibration arising externally. This provides a bearing surface, when partly inflated, of over 150 square inches and, since the total weight suspended is about 125 lbs., the internal pressure is less than one pound per square inch and the rubber is not sufficiently tense to transmit much vibration.

The corner posts, the corner braces of the frame, lead weights attached to the lower front edge to correct the balance, and a windlass provided to lift the weight off the rubber ring when the camera is not in use have been omitted from the drawings to avoid confusion. Likewise, wooden boxing around the upper platform and the parts above it and black curtains hanging around the camera to facilitate focusing have not been shown.

Of course, no claim of originality is made, unless it be for the


A
C
D
E
E
E
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15 IN.
6 FT.
E

method of support. Microscope and camera have long been used in a vertical axis, and there are several reports of the use of reflex cameras for photomicrography. Some equipment having this feature is now offered by the optical houses. Our camera has been in use more than three and a half years and has proven most satisfactory. Its only inconvenience has been a somewhat increased complexity in centering the light, owing to the use of the lower mirror. There is also lessened freedom in the placing of accessory lenses between the lamp and the substage when such are necessary. Its advantages are its freedom from vibration, a bellows extension providing an image-distance range between 35 and 85 cm. thus producing a good overlap in magnifiication between various lens combinations, a required over-all floor space of only 19 x 27 inches, and the very great convenience of being able to stand or sit with one eye at the focusing glass and reach with ease the microscope stage or the focusing knobs with the hand.

CAPTION FOR DRAWINGS

Drawings showing main features of the suspension and adjustments. On the left is a frontal projection. On the right a lateral view of a section through A-B. As mentioned in the text, the supports of the platform (C) and a few other details have been omitted.

EUROPEAN JOURNALS AND THE WAR

The non-receipt by a subscriber of any European chemical or other scientific journal seriously needed as research matter should be promptly reported to the American Documentation Institute.

The Cultural Relations Committee of ADI, which cooperates closely with the Cultural Relations Division of the Department of State, is working on this problem, and hopes to be able to surmount such war obstacles as interrupted transportation, embargoes and censorship, which so grievously affected the progress of research during the last war.

The principle should be established, if possible, that the materials of research having no relation to war shall continue to pass freely, regardless of the countries of origin or destination.

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THE INTELLIGENT USE OF NUMERICAL APERTURE*

L. V. FOSTER†

THIS discussion pertains more particularly to the microscope condenser and its use than to the objective. Since this is the most natural place to govern numerical aperture, the condenser and its various forms will be treated very carefully. However, before entering into a discussion of numerical aperture and its use, and rather than refer to articles on resolution, a brief explanation of the theory of resolution will precede the main subject.

The meaning of resolution placed by those who have theorized on the subject is, that if an object having periodic structure can be seen to have the same frequency of structure as the object, it is resolved. This covers a very broad group of subjects ranging from a picket fence viewed with the naked eye to the markings on diatoms viewed with a high power microscope. The resolution of the picket fence is a function of the distance from the center of one picket to the next, the distance at which it is observed and the rod and cone structure of the eye. All visual resolution depends upon this later condition and the condition varies in individuals. Physiological opticians claim that the average human eye has a resolving power of 1.5 minutes. They say that some eyes can resolve as little as 0.5 minutes. If we put this angular measure in terms familiar to us, a series of lines on a white background having intervals of 0.11 mm or 0.004 inches and held 10 inches from the eye will subtend at the eye 1.5 minutes. If you look at such a series of lines and can say that they are lines and not just a gray area, you can resolve 1.5 minutes.

If the eye could adjust itself to see objects sharply when they were brought closer to the eye, lines having a smaller separation could be seen. Since this is not the case, when objects get real small, we take them to a microscope to see them. The microscope may be only a hand magnifier or it may be a compound microscope. The latter will only be considered, since the former is equivalent to bringing the object closer to the eye.

It is well known that a compound microscope consists of two different lens combinations, the combination nearest to the object being called the objective, and the combination nearest to the eye being called the eyepiece. In all microscopes, the eyepiece is simply a magnifier used

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† Bausch & Lomb Optical Co., Rochester, N Y.

to view the real image formed by the objective and the eyepiece plays no part in either determining the resolving power of the microscope or in resolving the object. This is the full function of the objective. As mentioned above, the objective forms a real image of the object. It is necessary to put into the image a resolved picture of the object; otherwise the eye cannot see the object as it actually exists.

We have been taught that light travels in straight lines. We have also been taught and it can be demonstrated that when plane waves pass through a narrow slit, a screen placed some distance from the slit will have an unequal distribution of light. This unequal distribution is due to bending of the light at slit edges. The distribution of light is a function of the wave length and the width of the slit. The effect is more outstanding if a series of equal width slits are arranged parallel to each other. This effect is known as diffraction. Definite diffraction patterns are formed and because the amount of bending is a function of wave length, the diffraction patterns form several series of spectra. The general name applied to such series of slits is grating. The grating is the periodic structure mentioned in the first part of this paper.

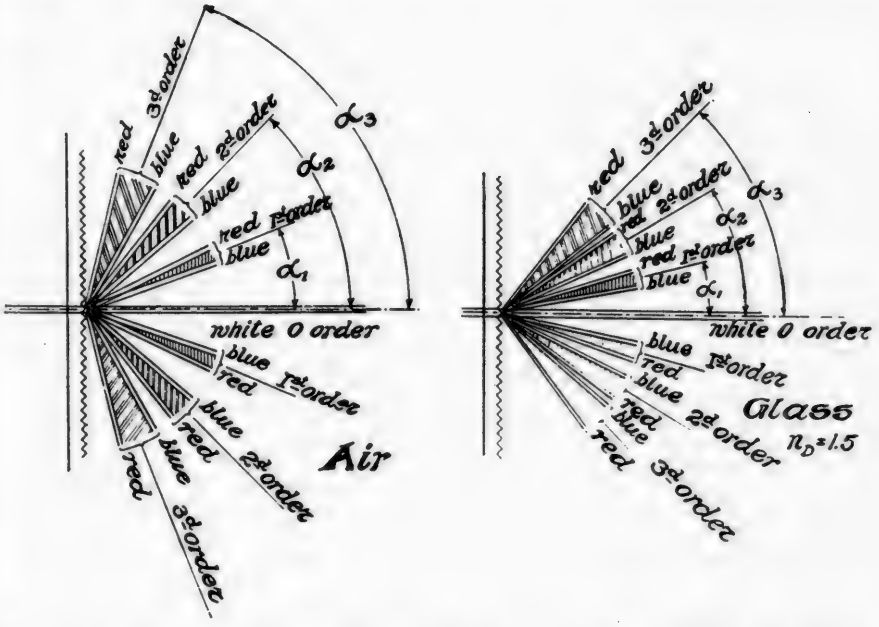

Figure 1. Diffraction spectra produced by a grating. If the spectra are formed in media denser than air, such as glass, the spectra are crowded close together.

Figure 1 shows the way light is diffracted upon passing through a grating. The grating is illuminated by a parallel beam of light, a part of which passes directly through the grating without deviation. This part is called "white zero order." On both sides of this beam are diffracted beams. These beams are broken into the colors of the spectrum because the amount of bending is a function of the wave length of light as well as the grating constant. The red end of the spectrum is bent more than the blue end and the first colored beam from blue to red on each side of the zero order is called the first order, the second colored beam the second order, etc. A relationship between these diffracted beams and the zero order is given in the following equation:

$$\sin a_k = \frac{k}{n} \frac{w.l.}{d}$$

where a_k is the angle the kth order makes with the zero order, n the refractive index of the medium in which the diffraction takes place, *w.l.* the wave length of light and d the distance from the center of one line to the center of the next in the grating. If n becomes greater than *w.l.* the various spectra become crowded together.

Professor Ernest Abbe proved that if an image having the same periodicity of structure as the periodic object was to be formed by a microscope objective, the objective would have to accept light which exists in the first diffraction spectra on at least one side of the central undeviated beam of light passing through the grating and this central undeviated beam. These two beams of light are reunited in the image plane of the microscope objective and form an image exactly like the object. If only one of these beams, say the central undeviated beam, can pass through the objective, there will be no image of the structure. The latter will look like a gray mass. The resolving power, or ability to receive such beams of light is a function of the numerical aperture of the objective and the wave length of the light. That is, 1/2 N.A.

This is a purely theoretical condition and in order to be executed requires the illumination of the object by a parallel pencil of light. This can be done without a condenser of any kind and by using a strong and distant light source. The effect is not one which we are accustomed to and the image is likely to be rather low in brightness. Furthermore, dirt specks and smears on any of the lenses of the eyepiece or the objective appear in the field. A test which may be easily carried out is to take a diatom slide with Pleurosigma angulatum, a 4 mm. 0.85 N.A. objective and a 10X eyepiece. Remove the condenser and tilt the mirror so that a centered beam of light will pass through the objective. Use

either the sun as a light source, a bare arc lamp set up about 15″ from the microscope or any strong source of light, such as a ribbon filament bulb, and observe the diatom. It will be clearly seen to consist of a diamond structure. This structure can be enhanced by slightly tilting the mirror to throw the illuminating pencil slightly off the axis of the objective and bring into the aperture of the objective a little more of the first order diffraction spectra. It has been pointed out that the first diffraction spectrum plus the central beam of illumination must be received by the objective in order that an image like the object may be seen. To know whether this image should be expected, remove the eyepiece and look down the body tube at the back of the objective. At the edge of it there should be six tiny spectra and in the center a bright beam of light, if the diatom is to be seen.

Only few objects are like diatoms. In general, objects are small, thin masses having granular or fibrous structure within them. The fibrous structure is similar to the diatom but the granular structure is quite unlike the diatom. An object similar to the granular masses is a single bacterium. Bacteria appear in rod forms, chain forms, double and single. These must be recognized as such in clinical work. A single bright dot can be seen as a single dot no matter how small it is, if it emits sufficient light. A single bright line can also be seen as a single bright line no matter how narrow it is, if it emits sufficient light. A single black dot on a bright field is less apt to be seen than a bright dot. The effect of light produces stimulus to the eye which gives us vision. In the case of the black dot, the region around the dot gives the stimulus to the eye, while the dot is only a small void in this large field of light. To see the dot, it must subtend an angle at the eye equal to the resolving power of the eye. To see a black line, the width of the line may be much smaller than will subtend this same angle at the eye. This is a physiological phenomenon which will not be discussed.

The function of the microscope is to illuminate an object so that the image will represent the actual form and size relationship of the various detail within the object. We speak of illuminating the object because we are only familiar with non-self-luminous objects. The object is therefore opaque, semi-opaque, or may at times be transparent. Transparent objects will not be discussed.

A brief discussion of condensers is worth while at this point. A substage condenser is any lens placed between the light source and the object which causes light emitted by the source to be converged upon the object. The substage condenser is made in several forms, the most popular being the 2-lens Abbe condenser. Other forms are aplanatic, achromatic and dark field. With any bright field condenser it should be

possible to completely fill the aperture of the microscope objective with light. To understand this statement we must refer to Prof. Abbe's theory. The central undeviated beam of light, together with the first order diffraction spectrum produced by an object, must be received by the objective, if the object is to be resolved. It must be remembered that a grating will give a first order diffraction spectrum on either side of the illuminating pencil of light. Abbe's statement does not place any restriction on what part of the objective the central undeviated beam of light must pass. This beam can be on the axis of the objective or it can be off the axis of the objective, when it becomes oblique to the object plane. Thus, if the first order diffraction pattern from a grating does not enter and pass through the objective when the illuminating pencil is parallel to its axis, i.e. centered, it may pass through by causing the illuminating pencil to be oblique. The obliquity can become as a maximum equal to half the angular aperture of the objective. In order to pass this obliquity of light through the objective, the aperture of the condenser must be at least equal to that of the objective.

The Abbe condenser, since it consists of only two spherical lenses and is rated at 1.25 N.A., is not corrected for spherical aberration. Figure 2 shows such a condenser. Two rays parallel to the axis are drawn

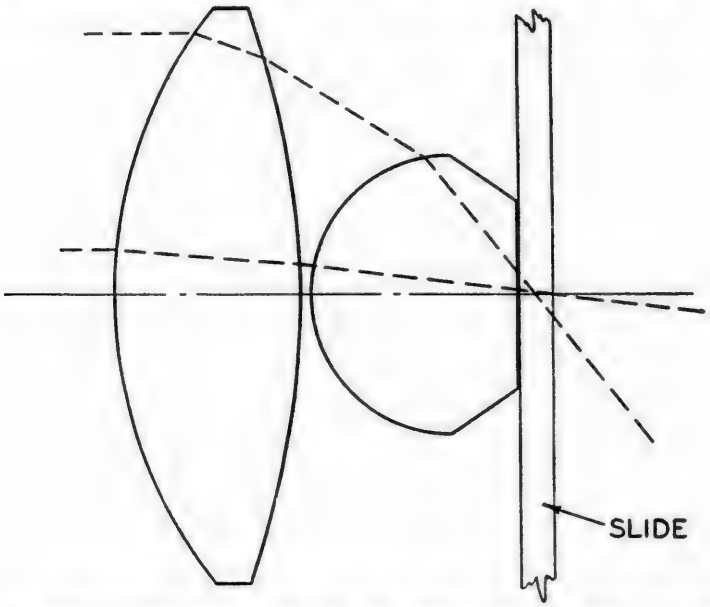

Figure 2. Abbe Condenser — note that the edge ray falls inside the slide. This is spherical undercorrection.

to show that the light rays near the axis come to focus on the surface of the slide but the rays near the edge are brought to focus inside the slide. If an object such as a diatom is used and the light falling on the condenser is parallel, the resulting obliquity of light is not equal to that expected from a 1.25 N.A. objective. That is, if one attempts to pass through the diatom a small parallel beam of light just inside the aperture of the objective, this beam of light will not reach the object. An Abbe condenser is not a good form of condenser to be used where high numerical aperture is needed to resolve small structure because the strongly oblique rays of light do not come to focus in the plane of the object, and can therefore not produce the undeviated zero beam of light so necessary to cause diffraction.

The aplanatic condenser usually consists of three lenses and is made to have 1.40 numerical aperture. Figure 3 shows an aplanatic condenser. Two rays parallel to the axis are drawn to show that both edge

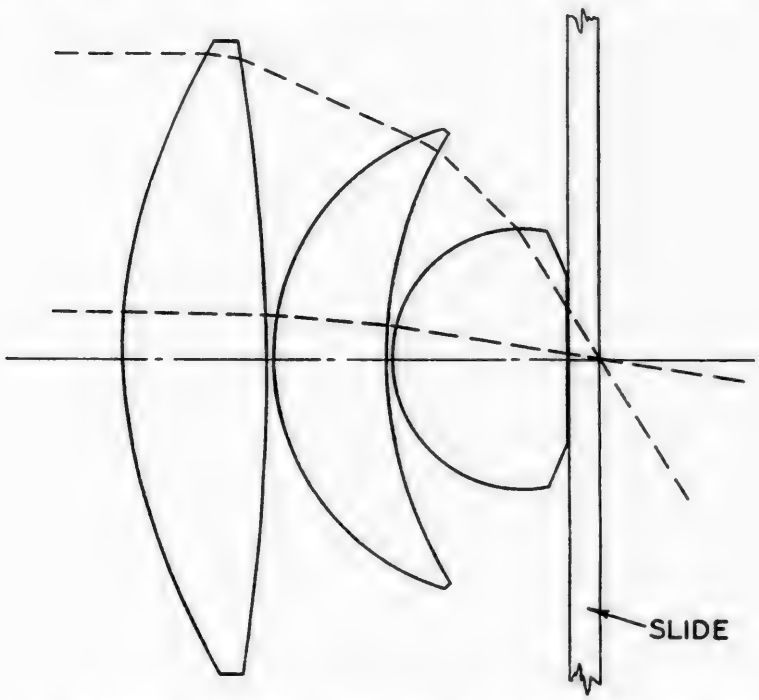

Figure 3. Aplanatic Condenser — note that the edge ray and the central ray cross on the surface of the slide. This condenser is corrected for spherical aberration.

and central rays come to focus on the surface of the slide. Since it is aplanatic and therefore corrected for spherical aberration, marginal parallel pencils will be brought into focus on the object. This will allow the central undeviated beam of light to be made to pass through the specimen obliquely. An object too finely divided to be resolved can be resolved by oblique illumination, since the zero order will pass through one edge of the objective and the first order will pass through the opposite edge. Thus, when this beam and the first order diffraction beam pass through the objective, the structure will be resolved. This could not be done with the Abbe condenser because the oblique pencil of light suffered spherical aberration.

In critical microscopy, filters are often used to enhance the contrast in pale tints which are the rule in stained objects. The Abbe condenser and the aplanatic condenser are not corrected for chromatic aberration. This means that the focal point for red rays is between the condenser and the focal point for blue rays. Thus, if the condenser is focused in white light, the focus is somewhere between the red and blue focus. If either a red or blue filter is placed between the light source and the eye, the condenser is apt to be out of focus. Figure 4 shows an

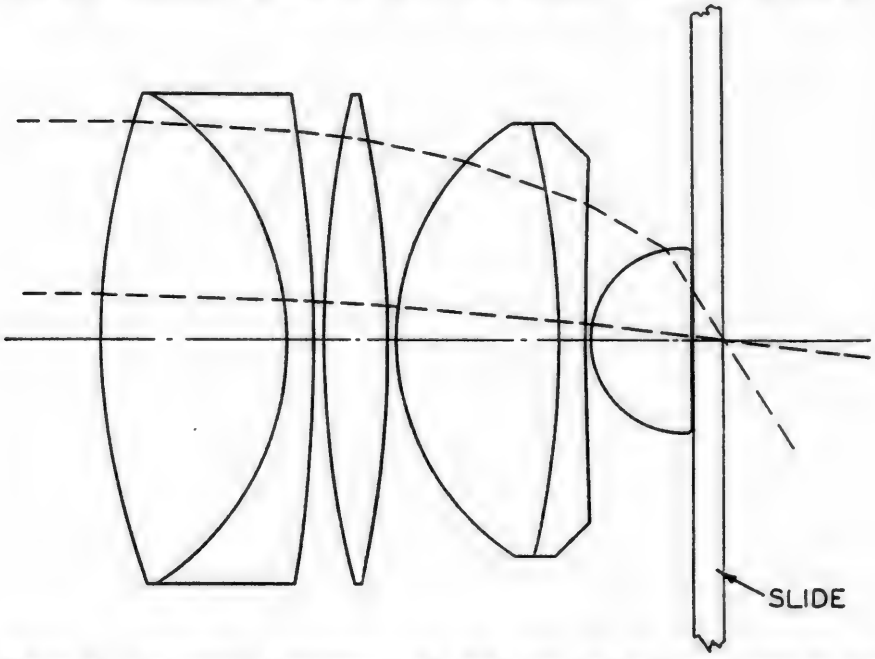

Figure 4. Achromatic Condenser — all rays, both red and blue, cross on the surface of the slide. The condenser is spherically and chromatically corrected.

achromatic condenser where all zones bring light to focus on the surface of the slide for any color.

The achromatic condenser provides a means for securing the nearest approach to the ideal illumination of microscope objects. With this condenser, one can use any part or all of the aperture of the condenser and be quite certain that the part used will get through the object and into the objective. He can use any wave length of the visual spectrum for illuminating the specimen and be certain that the specimen will be efficiently illuminated by that wave length.

To see coarse details or contours only does not require much attention to refinements of illumination. When one attempts to see or record the finest detail in objects the importance of illumination becomes evident. The field must be evenly illuminated and it must be possible to fully fill the aperture of the objective with an even beam of light. If a strictly parallel beam of light falls on the condenser, an infinitesimally small field will be illuminated, since the parallel beam will be brought to focus by the condenser into a point.

No source of light is a point and therefore there can be no strictly parallel beam of light. If the source is a lens surface, this surface has a finite size and must therefore be imaged by the condenser as a finite size spot of light. There are two forms of illumination systems, one called critical illumination and the other called Koehler illumination. In critical illumination, the light source is imaged by the substage condenser on the specimen. In Koehler illumination, figure 5, an evenly illuminated lens surface acts as the source of light and is imaged by the

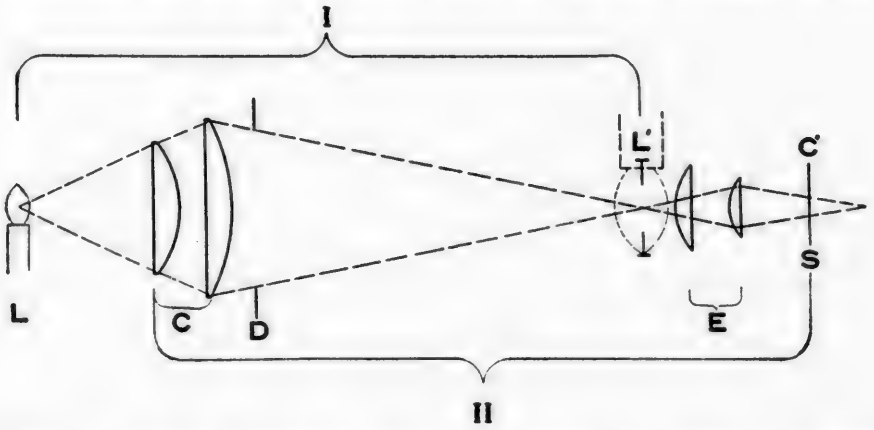

Figure 5. Koehler illumination system. Light source, L, is imaged in substage diaphragm at L′. Lamp diaphragm, D, is imaged in object plane, S.

substage condenser on the specimen. In this form of illumination, the aperture of the substage condenser is filled with light in the form of an image of the light source. The evenly illuminated lens surface is the lamp condenser. This is the most used system of illumination, since an iris diaphragm can be placed at the lamp condenser and can be used as a field diaphragm. Aperture of the illumination system can be controlled by the iris diaphragm directly below the substage condenser.

EXPLANATION OF FIGURES

The photographs which are reproduced here were all made with Koehler illumination. They show various structures which are difficult to reproduce without extreme care in adequate aperture illumination.

Figure 6. Hensen's and Krause's membrane in human heart muscle. 1400X; 3 mm, 1.40 N.A. apochromatic objective wide open.

Figure 7. Mitosis in pine root. 1400X; 4.3 mm, 1.00 N.A. fluorite objective wide open.

Figure 8. Backbone of cat. 1400X, 4.3 mm, 1.00 N.A. fluorite objective wide open.

Figure 9. Syphilis spirochaeta. 1250X, 1.8 mm, 1.30 N.A. fluorite objective, taken at 1.20 N.A.

Figure 10. Trypanosoma. 1400X, 2 mm, 1.30 N.A. Apochromatic objective, taken at full aperture.

Figure 11. Streptococcus pyogenes. 1350X, 2 mm, 1.30 N.A. Apochromatic objective, taken at full aperture.

Figure 12. Streptococcus pyogenes. 1350X, 2 mm, 1.30 N.A. Apochromatic objective, taken at 0.85 N.A. Note the diplococci above the stretococcus are scarcely recognizable. Also note the short chain at the bottom and left of the strepococcus could not be recognized—reducing numerical aperture sacrifices resolving power.

Figure 13. Spore-bearing bacilli. 1350X, 2 mm, 1.30 N.A. Apochromatic objective, taken at full aperture.

Figure 14. Spore-bearing bacilli. 1350X, 4 mm, 0.65 N.A. Achromatic objective, taken at full aperture. Note the difference in sharpness between this picture and figure 13. The loss of sharpness is due to low resolving power and too high magnification.

Figure 15. Pleurosigma angulatum. 1350X, 4 mm, 0.95 N.A. Apochromatic objective. Taken at 0.60 N.A.

Figure 16. Pleurosigma angulatum. 1350X, 4 mm, 0.95 N.A. Apochromatic objective. Taken with pin-hole diaphragm. Note the diffraction rings in the field. There are due to specks of dirt on the eye-piece. The structure is still definitely recognizable.

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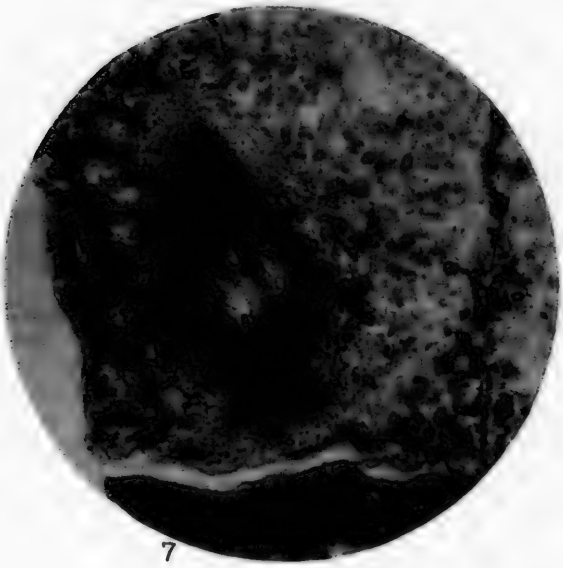

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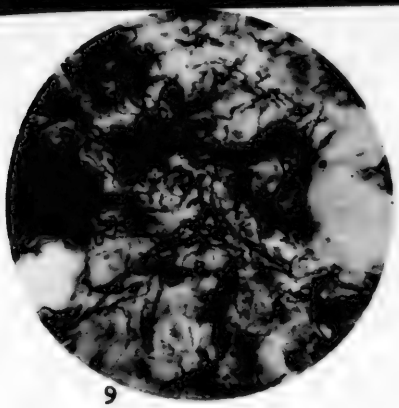

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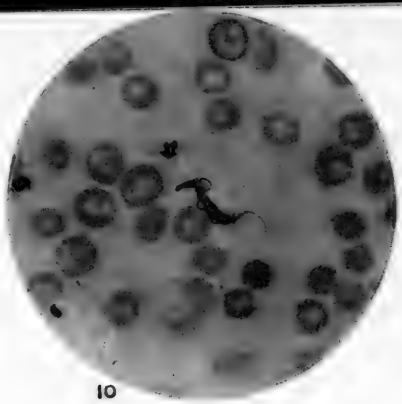

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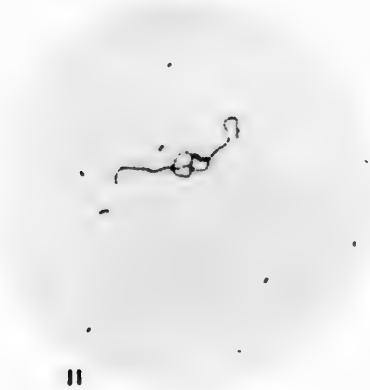

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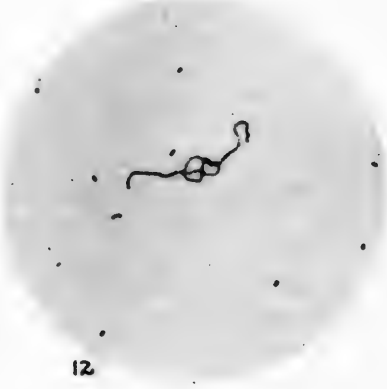

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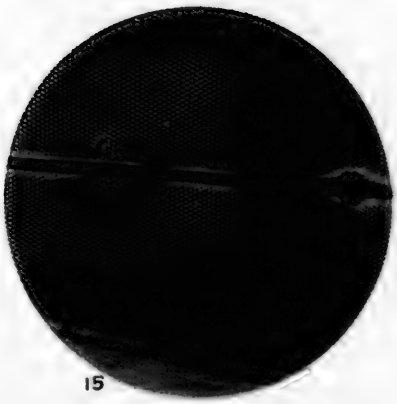

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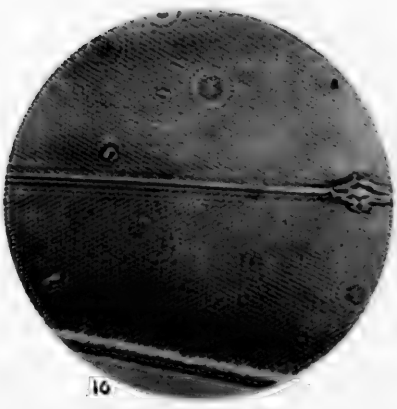

16

NATURAL COLOR PRINTS FROM SINGLE NEGATIVES*

R. H. PECKHAM, Ph.D.†

WITH certain subjects, and under certain conditions, color transparency and separation negative methods of obtaining color prints fail. This may be due to optical restrictions imposed by the situation, or to the difficulty of reproducing certain color combinations. The author's problem has been to provide some sort of color reproduction of the retina of the eye, or fundus oculi. Since the exposure must be made, in this case, through the dilated pupil of the living human eye, with a Zeiss-Nordensen fundus camera, the exact amount of light which finally reaches the plate cannot be predicted. Attempts to use Kodachrome yielded indifferent results, due to this irregularity of exposure.

It has been found by experiment, that the best fundus negatives are made with extremely rapid orthochromatic emulsions. The higher green sensitivity of these emulsions acts in a manner comparable to a light green filter and panchromatic stock, without the disadvantage of increasing the exposure for a filter factor. These negatives are processed in fine-grain developer, and are usually enlarged from one-inch negatives, to six-inch circles for display. The particular effect of this emulsion is to express the reddest retinal areas as the darkest parts of the monochromatic print, and the lightest retinal areas as white. Since the retina itself is colored almost exclusively in purple, red, orange, yellow and white, an analysis of the color of the retina becomes possible from close and repeated examination of the black and white prints. A diagrammatic scheme of the process is shown in figure 1.

Attempts to reproduce successful Kodachrome pictures of the retina by the separation negative process demonstrated that for this particular subject, the three separation negatives varied almost entirely in contrast alone, rather than in definite color separation. It was therefore decided to attempt to produce a color print by preparing three wash-off reliefs of increasing contrast from a single orthochromatic negative. The motivation was principally one of curiosity, to demonstrate the effectiveness of the analysis described above. A normal wash-off was first prepared, with the aid of trial strips, and two others prepared with exposures one-half, and one and one-half times this basic exposure. Let these three be described as normal, thin, and heavy. All three wash-offs were

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† Dartmouth Medical School, Dartmouth Eye Institute, Hanover, N. H.

Medullary Fibers	exudates, disc	retinal background	arteries	veins	choroidal pigment	
white	yellow	orange	red	purple-brown	dark brown	Colors of object
5	4	3	2	1	0	Densities of negative
0	0	1	2	3	4	Contrasty Wash-off print
0	1	2	3	4	5	Flat or normal Wash-off print
RP-0	RP-0	RP-1	RP-2	RP-3	RP-4	Imbibition of contrasty print
Y-0	Y-1	Y-2	Y-3	Y-4	Y-5	Imbibition of normal print
white	yellow	orange	red	brown	purple-black	Colors of print

FIGURE 1

Color printing from a single negative by the dye-imbibition process. The process is available with single negatives only when the colors can be arranged in a consecutive scale by using a particular negative material, or negative-filter combination. The case illustrated has been worked out for the fundus oculi (retinal background) of the human eye. The relative densities of the negative and prints are arbitrarily expressed as a series from 0 to 5, where zero expresses transparency and 5 maximum darkness. The contrasty print is prepared by underexposure and overdevelopment. The symbols "RP" and "Y" refer to the dyes used, a mixture red-purple in color for the contrasty print, and another dye of yellow color for the normal print.

developed in D-72, diluted 1-1, with 1 per cent potassium bromide added, for two minutes at 18° C. Subsequent processing differed somewhat from the instructions supplied by the Eastman Kodak Laboratories.[1] After two minutes washing in cool water, the wash-offs were bleached in R-10a, (A: ammonium bichromate 2 per cent, sulphuric acid 0.4 per cent, B: sodium chloride 4.5 per cent), diluted 1 part of each stock solution to 4 parts of water. The reliefs were developed as soon as bleaching was complete, in hot tap water at 44° C. They were then fixed in ordinary acid hypo for 30 seconds, washed for 30 seconds in hot water (44° C.), and soaked for two minutes in a 5 per cent formalin hardening bath. They were dried rapidly before dyeing to further harden the relief image.

Since the dye-imbibition process lends itself to complete control of contrast by variation of printing exposure, and complete control of density by variation of dye-concentration, it was thought possible to print these three matrices from a single negative, as follows.

A thin relief, if printed with a highly concentrated dye, will yield a very contrasty print. This relief was therefore printed in a red-blue dye. The normal relief was printed in a red dye. The heavy relief was printed in a weak yellow dye. The result was a general tone of yellow dye over the whole print, red-to-orange color in the half-tones, and red-to-purple color in the shadows. This print was not only pleasing, but also after some manipulation of concentration of dye-bath, yielded a good imitation of the actual retina, superior to a similar three-color separation-negative print of a good Kodachrome transparency.

It was found by experimentation that certain dyes were more sensitive to acetic acid than others. The effect of this sensitivity is to definitely effect the contrast of the print when the reliefs are briefly rinsed in acetic acid of different dilutions after leaving the dye-bath, and before being imbibed. Specifically, it was found that increase of acetic acid for the final rinse, from 0.1 per cent to 0.5 per cent would greatly effect, and increase the contrast, in a print made with the aniline dye Cyanole FF, but that very little effect was shown with the aniline dye Azo Fuchsin 6B Conc. A combination of these two dyes was therefore used with the normal relief matrix (cyanole 0.02 per cent, fuchsin 0.04 per cent, acetic acid 0.5 per cent). The print from these two dyes in a single bath yielded a two-color effect. The shadows were found to be purple, the half-tones red, and the high-lights white. The thin matrix was discarded, and a second heavy matrix, exposed one and one-quarter times normal, was prepared. This was dyed in a combination dye-bath of Tartrazine 0.1 per cent and Mentanil Yellow Conc. 0.01 per cent.

[1] Color Printing from Wash-off Relief Film. Eastman Kodak Co.

A similar negative was used for a repetition of the system outlined above, and it was found that the two matrices, normal and heavy, varied slightly in density from the first pair, and that therefore the dye-baths had to be adjusted to overcome this difference. This adjujstment was slight, and was accomplished by adding dye to the normal matrix bath, and adding distilled water to the heavy matrix bath. Succeeding prints have demonstrated the feasibility of the process for this specific subject. Prints in color are therefore possible for any of the hundreds of negatives of the fundus oculi made in this laboratory in the past four years.

Since the crux of the plan depends upon choosing a subject with related colors, other prints were attempted of different subjects. A tumorous mass, for example, photographed with orthochromatic film, requires almost the same colors. The differences specific to the subject are accomodated for by either changing the dye concentration, the relief contrast, or the acetic acid bath.

By taking advantage of the specific effect upon dye-baths by acetic acid concentration, a photograph of growing wheat, taken with panatomic film, without a filter, was printed in good imitation of natural color with a dye-bath of Tartrazine 0.1 per cent and Acid Green J. A. 0.02 per cent. The whole print was then soaked five minutes in Patent Blue A, 0.0005 per cent. The resultant print showed green shadows, yellow high-lights, and a blue sky.

At present the method remains anecdotal, in that each specific problem must be approached separately, with very few interrelated and universal rules that can be applied. What few rules can be derived at the present stage of the process are these; the subject should be one of successive colors, such as purple-red-orange-yellow-white, or blue-green-yellow; the negative, hence the emulsion chosen and the filter, must arrange these colors in a descending sequence; the matrices and the dye-concentrations must be individually controlled for specific subjects; the operator must have previous and exact knowledge of the colors in the subject; the dye-baths may be composed of any of the many acid anilin dyes for animal fibers. In spite of these limitations, the process can be applied to specific subjects, when the recurrence of the subject matter is frequent enough to justify the establishment of a system. In this manner it becomes possible, by synthesis, to produce natural color prints from single monochromatic negatives.

USE AND APPLICATION OF PHOTOMICROGRAPHY IN MYCOLOGY

TIBOR BENEDEK, M.D.*

IN a previous paper we dealt with the use of photography in mycology for larger objects as macro-cultures, test tube cultures, etc.[1]

The use of photomicrography in mycology has documentary value. It is, therefore, superior to drawings. It reproduces the details of microscopic fungi, Hyphomycetes and yeasts, almost on the same scale as seen at visual observation and as it will be observed afterwards by other investigators.

Drawings of miscroscopic fungi are unnecessary, because the third dimension does not play a role, in contradistinction to higher plants, and drawings are often confusing. They usually give a superdimensional presentation of the objects and thus represent an empty magnification. Details can be identified with the original objects with difficulty. In my teaching experience I frequently notice the amazement of my students when they compare a living specimen under the microscope with published drawings of the same fungus. A drawing is a representation of the impression made upon the artist, thus certain features are often unduly accentuated.

Photomicrography, on the contrary, avoids all these criticisms: it is objective, true, documentary and it represents the details in the manner and on the scale which the worker is accustomed to use in visual observation. These considerations gain more and more recognition among workers in this field as evidenced by the increase in the use of photomicrography in periodicals as well as in books.

To simplify the use of photomicrography in mycology we must consider the proper way of culturing the fungi in order to make them easy to photograph, and the proper photomicrographic equipment.

The medical mycologist deals with two chief groups of fungi: Hyphomycetes and yeasts, or yeast-like bodies.

To prepare yeast cultures for photomicrography is simple. The hanging drop culture is the ideal method, presenting all the details in a two dimensional plane.

* Received for publication June 21, 1939. From the Laboratory for Mycological Research, Department of Dermatology, Service: Dr. A. W. Stillians, Northwestern University, Medical School, Chicago, Ill.

[1] T. Benedek, *J. Biolog, Photogr. Ass.*, 7:116-120, March 1939.

Quite different is the situation with Hyphomycetes. Hanging drop cultures are not appropriate for this purpose. The chamber of a hanging drop culture is very small, it contains a small amount of oxygen (it amounts almost to a semi-anaerobic chamber), and it admits, of course, a very restricted amount of nutrient medium. Most of the Hyphomycetes with which the medical mycologist has to deal are obligate aerobes. They soon use up the oxygen in the small chamber, exhaust the little drop of nutrient medium and often stop growing after germination or after the formation of a scanty mycelial growth. The mycologist is most interested in the organs of reproduction which, however, seldom appear. Thus the hanging drop cultures do not lend themselves to this type of investigation.

To avoid this difficulty I suggested many years ago a plan of inoculation which proved to be useful in the hands of many research workers.

In making photomicrographs of Hyphomycetes I use test tube cultures (thin walled tubes, 16 mm. by 160 mm. in size) of the species in question inoculated in a special way. Using slant agar tubes the inoculation is made in the angle between glass and nutrient medium, best in the thinnest portion of the slant agar, to give the Hyphomycetes opportunity to climb on the clear wall of the test tube having the thallus formed on the rich medium. In this way the culture has aeration, supply of oxygen filtered through the cotton plug, medium enough for an uninhibited growth for months, thus affording the investigator ample opportunity to observe every detail of growth. For more details on this subject, refer to my original paper[2]

To enable workers to use test tube cultures of fungi for microscopic observations and for photomicrography a special clamp was constructed which after publication was introduced in many mycological laboratories.

These clamps are applied on the stage of any microscope which has a fixed stage. They are interchangeable with the usual spring clamps supplied with the stage. Figure 1 shows these "mycological stage clamps," holding the test tube fast on the stage but allowing the tube to be moved in any direction in the plane. That a rolling of the tube is possible within the clamps is self-evident. A light pressure on the horizontal arm of the clamps is enough to fix the test tube in any position desired.

To make the clamps fit for use on the big revolving cross stage of the largest microscopes P. W. Schmidt,[3] using my primary suggestion, constructed and developed an analogous, but somewhat different type of

[2] T. Benedek, *Dermat. Wschr.*, 82:1-5, 1926.
[3] P. W. Schmidt, *Dermat. Wschr.*, 102:673-677, 1936.

stage clamp. The Benedek stage clamps[4] can be used also on the revolving cross stage, but they do not allow the full use of this stage, permitting only the longitudinal and not the revolving movement of the stage. P. W. Schmidt's construction made possible the full mechanical

Figure 1. The mycological stage clamps of Benedek.

utilization of the big cross stage of the research microscopes for these mycological stage clamps.

What are the advantages of these special clamps for photomicrography? These clamps make possible the exploitation of all the advantages a test tube culture offers for the observer; the registration of all the changes of the growth, from the germination of the inoculated spores to the final formation of organs of reproduction. Using my special mode of inoculation, test tube cultures can be observed and photographed easily with the high dry system. P. W. Schmidt suggested even a special oil immersion objective of C. Zeiss. This oil immersion 50/0.85 has a focus of 3.5 mm. and a working distance of 0.4 mm. The construction of this objective corresponds to that of the achromatic

[4] The Benedek stage clamps are made by Franz Hugershoff, Carolinenstr. 13, Leipzig Cl, Germany. I wish to thank this firm for permission to reproduce the cut in this paper from the *Dermat. Wschr.*, 82:4, 1926. In ordering these clamps it is necessary to give the size of the holes on the stage, because they are different on microscopes of different makes. P. W. Schmidt's modified clamps for the revolving cross stage can be made according to his sketch by any skilled mechanic.

oil immersion objective 90/1.25 of Zeiss, and its greater working distance makes possible its use through the test tube wall of variable thickness. The special advantages of the method are obvious. The cultures need not be disturbed or destroyed for the sake of microscopic examination. A great series of cultures can be examined, photographed or even projected for a larger audience.

Now we can turn to the discussion of the photomicrographic equipment available today for the research worker in the field of mycology.

The first question arising is which is the most appropriate type of photomicrographic equipment for the individual worker, not having at his disposal all the phototechnical facilities of a large institution? The next question is which size can be used with the greatest efficiency? Have small negatives the preference with following enlargement or is the larger size, say, 3″ by 4″ more advantageous, permitting immediate contact prints from negatives?

The great American optical manufacturers as Bausch & Lomb, Spencer Lens Co., and others supply suitable photomicrographic cameras. The various types, the rigid ones or those with bellows, can be used in the vertical or horizontal position for the size 3″ by 4″ and larger in connection with any conventional type of microscope which is fitted with a substage condenser. All these cameras use as their "photographic

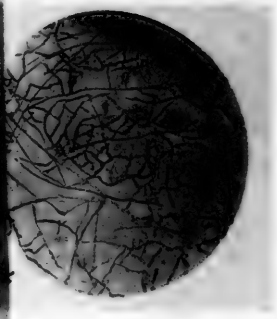
EXPLANATION OF FIGURES

Figure 2. Epidermophyton interdigitale, four weeks old culture on Sabouraud's maltose agar medium. Test tube culture. Photograph made through the wall of the test tube. Aleurospores as well as hyphae in the center focused, the rest, especially, the upper part of the photograph is entirely out of focus. Photograph taken by means of a Zeiss microscope and of a rigid camera of 4″ by 5″. Contact print from a 4″ by 5″ negative.

Figure 3. Rhinosporidiosis of the mucous membrane of the nose. Section stained with hematoxylin-eosin, showing unripe and ripe sporangia. Center focused, definition falling rapidly, especially at the left side of the photograph. The same equipment as in figure 1. Contact print from a 4″ by 5″ negative.

Figure 4. Microsporum equinum Bodin, four weeks old, on rice medium. Photograph taken through the wall of the test tube culture by means of a Zeiss microscope and of the photomicrographic attachment "Phoku." Use enlarging glass and see the perfect definition all over the field. Contact print from the plate of 4.5 cm. by 6 cm.

Figure 5. Enlargement of the photograph in figure 4. Compare the sharp definition of the chlamydospores and of the hyphae in the center and anywhere at the periphery. The enlargement was brought to the size of a 4″ by 5″ plate.



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eye," the standard eyepiece of the microscope. For those who are thoroughly familiar with the optics of a microscope, it is hardly necessary to say where the troubles lie. For those who are, however, less familiar, it is necessary to give a few helpful suggestions.

Eyepieces of the Huygenian type, and even compensating eyepieces, when used as projection oculars in connection with a photographic camera, never can give a plane image on the screen or on the photographic plate. Because of the curvature of the image formed by the objective either the center, or the periphery of the object can only be focused with critical definition on the ground glass or mirror glass of the camera, but never the whole field of vision at the same time.

To illustrate this statement figure 2 shows the photomicrograph taken with a 4″ by 5″ vertical camera of domestic make. The microscope used was a large Zeiss microscope with fluorite objective and compensating eyepiece. The result is rather unsatisfactory. Figure 2 represents the original contact print from the 4″ by 5″ plate, from which all the peripheral portion was cut out because entirely out of focus. The reader can moreover easily observe how small a portion of the print given is in focus. The periphery is still out of focus. Figure 3 illustrates the same point on another field.

The conclusion derived from this experiment is, that the use of these larger sized plates can not be advocated, due to the waste of time and material.

Figure 4 is a photomicrograph taken with the same Zeiss microscope in connection with the Zeiss photomicrographic attachment "Phoku." The principles of "Phoku" are entirely different. Instead of the compensating eyepiece, negative lenses (Homals) are used as projecting eyepieces. They give an ideally uniform flat field. The size is 4.5 cm. by cm., and the image measures 33 mm. in diameter. It is regrettable that the firm discontinued this excellent type of photomicrographic attachment because of its expense.

Figure 5 shows the enlargement of the 33 mm. photomicrograph. As can be seen, the enlargement yielded perfect definition over all.

There is, however, another reason why these large sizes are unnecessary for the mycologist.

If the botanist wishes to illustrate the prototype of an oak tree, for instance, he will not depict a whole forest. One single oak tree, one leaf, one blossom, one acorn, — that is all he needs.

If the mycologist wishes to show the type of the thallus and the organs of reproduction of a given species he will usually find all the necessary details in one or two very small fields of vision. Figure 4 shows the entire microscopic aspect of Microsporum equinum Bodin grown

on rice medium. Several square inches depicted would demonstrate nothing more. Here is shown the type of thallus and the only type of reproductive organ on the rice medium: chlamydospores. It is, therefore, obvious that a single small, characteristic field offers a much clearer, more impressive picture of the object in a 33 mm. picture than on a surface of 4″ by 5″. The large size is only covered with the repetition of the same details distracting the eye from the main point of the presentation. The general tendency in photography, especially in photomicrography, is more and more in the direction of using the miniature camera with enlargement.

Fred A. Mettler[5] a short time ago in an excellent article dealt exhaustively with this problem of negative enlargement in photomicrography. We refer the reader to this article for many valuable details.

I advocate the miniature camera for purposes of the medical mycologist for the reasons given above. We have different types of miniature cameras on the market: the "Miflex" of Zeiss (see pamphlet Micro 503e) is a photomicrographic camera only, and there are photomicrographic attachments to the Leica and the Contax enabling these miniature cameras to be used in connection with the microscope.

The "Miflex" which replaced the "Phoku" is an universal camera attachment with focusing telescope. The fundamental difference between the "Miflex" and the discontinued "Phoku" lies in the absence of the intermediate optical system (Homals) for focusing the image on the photographic plate. A variety of eyepieces can be employed, including photographic eyepieces, and the instrument can be used not only with the standard microscope comprising an objective and an eyepiece but also with the so-called simple microscope. This attachment allows the use of plates (6 cm. by 9 cm., 9 cm. by 12 cm.) or with the Colibri 3 by 4 cm. attachment it becomes a roll film camera taking 16 pictures 3 by 4 cm. on a standard A8 spool, figure 6. Another advantage of this equipment is that it allows the "Miflex" to be used with the miniature camera Contax (cine film 24 mm. by 36 mm.).

The "Miflex" uses the eyepiece of the microscope as a projecting ocular. The same criticism holds for this attachment with regard to the curvature when the photographic eyepieces are not used, but to a far lesser extent, because of the smaller size and especially because of the fact that the plane of the photographic plate is much nearer to the rear lens of the eyepiece.

In this connection may I call attention to two new types of Zeiss lenses. They are intimately connected with the efficiency of photomicrography. First there are the new microscope objectives the Zeiss Planach-

[5] Fred A. Mettler, *J. Biolog. Photograph. Ass.*, 7:21-26, September 1938.

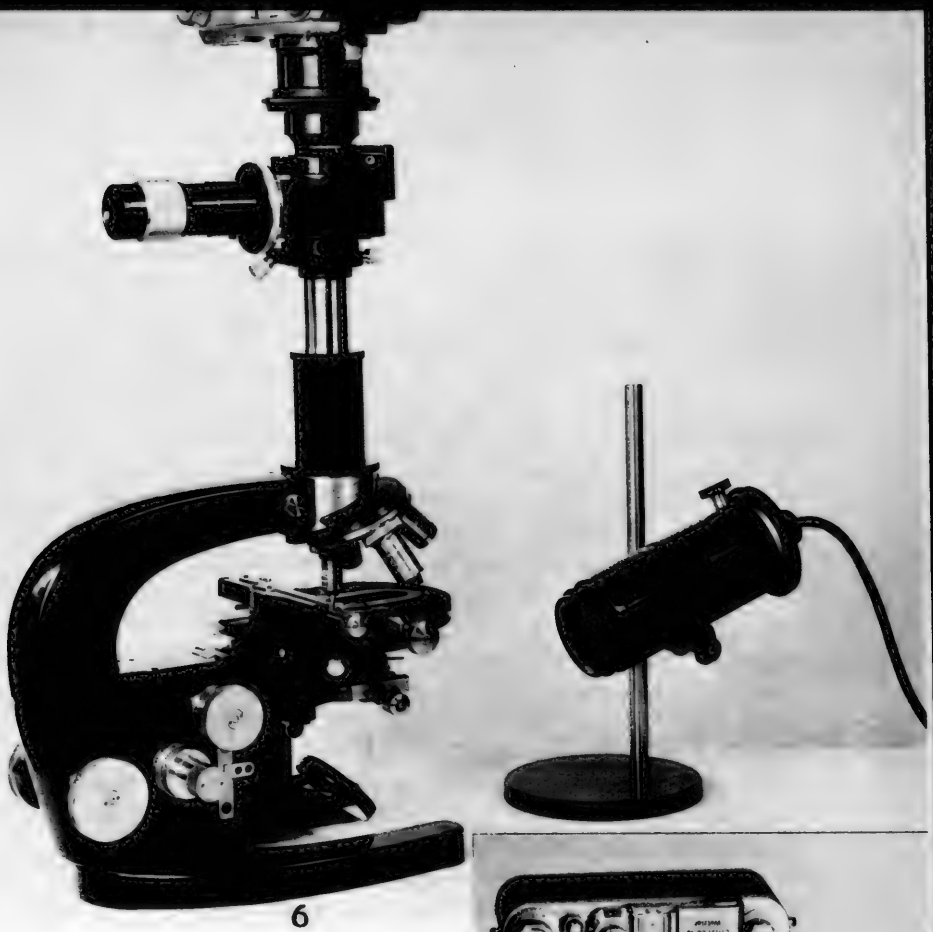

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FIGURE 6. Zeiss microscope in connection with the "Miflex."

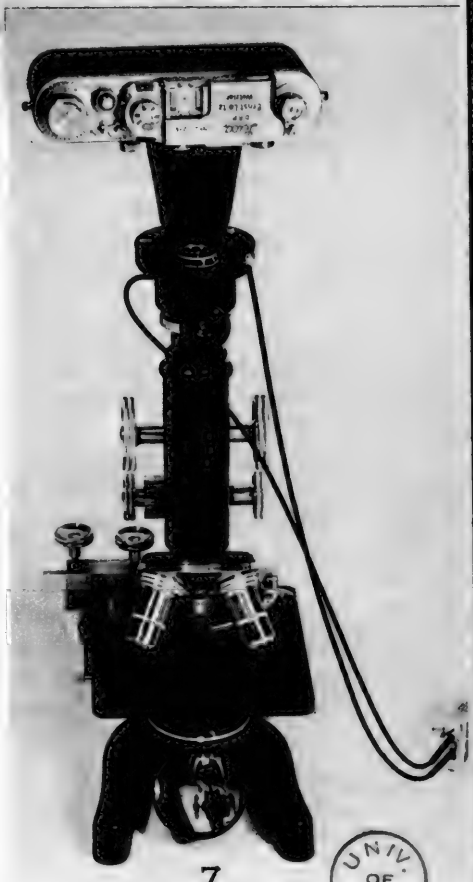

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FIGURE 7. Leica camera fitted to a Leitz microscope for photomicrography by means of the Micro Ibso attachment.

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romates, which are chromatically corrected, and, like the better photographic lenses, form a plane image of a plane object. There is no curvature of field or falling off toward the edges. There is a maximum definition from the center to the periphery. Consequently eyepieces with a wide angle can be used to full advantage.

The second innovation is the new "Homals." The purpose of Homals, like the Ampliplans of Bausch & Lomb, is to produce on the focusing screen or photomicrographic plate, a magnified image of the curved intermediate image as a flat plane coincident with the focusing screen or photographic plate. These "Homals" can be fitted to stands of other manufacture. They replace the usual eyepiece when the microscope is used for projection or photomicrography.

Finally for the benefit of those who possess a Leica we must mention the possibility of using this miniature camera for photomicrography. Figure 7 shows a Leica camera fitted to a Leitz microscope for photomicrography by means of the Micro Ibso attachment.

I use a Leica extensively for mycological work by means of the above attachment in connection with a Zeiss research microscope. This combination of two different optical systems — Zeiss objectives and Leitz compensating eyepieces — raises another important problem which must be discussed, because some one might use a Bausch & Lomb or Spencer microscope in connection with this attachment and the Leica.

The Micro Ibso attachment uses the eyepiece of the microscope for projecting the image formed by the objective to the plane of the film. In every make of microscope the eyepieces are, however, compensated only for the objectives of the same make. Zeiss eyepieces for Zeiss objectives and so on. This attachment made by Leitz, of course, uses Leitz eyepieces, an 8X or 10X periplan (compensating) eyepiece, in a mount which does not allow it to be interchanged with eyepieces of microscopes of different make. That means some inconvenience, more theoretical than practical, for in spite of this difficulty microscopes of other makes can be used with success, producing a picture which can be enlarged without any special loss of definition at the periphery. There is a practical problem which can be solved easily with a bit of good will and cooperation on the part of the interested optical companies.

The American optical manufacturers do not produce cameras of the type of the Leica of Leitz or of the Contax of Zeiss Ikon. Both of these miniature cameras are very popular with scientific workers. On the other hand Bausch & Lomb as well as Spencer microscopes are excellent, and in my experience they match the best continental makes. Would it not be possible to make the mount of the rear lens of the eyepieces of these domestic microscopes in such form as to fit the Micro Ibso at-

tachment? With this one change both these microscopes could be used in connection with an excellent miniature camera. The same difficulty exists concerning the Zeiss eyepieces. The rear mount of the eyepiece is too thick to be fitted in the mount of the Micro Ibso attachment.

I earnestly hope that the optical firms concerned will take into serious consideration this suggestion which can easily be carried out for the benefit of all concerned.

SUMMARY

This paper brings a short description of the mycologic stage clamps which have made test tube cultures of microscopic fungi available for purposes of photomicrography. A special method of inoculation of these test tube cultures is described. The most appropriate photomicrographic equipment for the mycologist is discussed. The large photographic cameras are considered to be inappropriate and unnecessary. The writer favors the use of miniature cameras (Leica, Contax) and calls attention to the useful novelties in this field (Zeiss Planachromats, Zeiss Homals) which enable the use of photographic equipment in obtaining perfect definition.

Finally an open request is made to American optical manufacturers to make the necessary change on the rear mount of the eyepieces of the excellent American microscopes which would allow them to be used with the miniature cameras Leica and Contax.

HOW WE MAKE SURGICAL FILMS*

PROF. H. DE LAS CASAS†

PART TWO. TITLING.

THE importance of proper titling has been emphasized by all writers. We prefer titles even in films that are commented by registered sound or microphone. In these the titles are like punctuation signs dividing the matter and giving the mind opportunity to grasp the significance of every scene. This conclusion made us abandon superimposed titles, the elegance of which we like although they do not serve as intervals or as a respite.

The best title is the simplest. Nothing equals a clear, straight, well-lettered and framed title.

LETTERING. In our type of films, the hand-lettered title is most

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†Department of Traumatic and Orthopedic Surgery, Hospital Vargas, Caracas, Venezuela.

satisfactory but hand-lettering with imperfect instruments involves so much trouble that the task is easily avoided. We use a German instrument, named Dingraph, which operates on the principle of the draftsman's pantograph. A point follows the letter which is engraved on a ruler while a pen at the other end traces it on the paper. Its only imperfection is a slight lack of uniformity in inking which is overcome by mounting in place of this pen, the German fountain pen for india ink, Pelikan Graphos, which allows the making of any type of letter.

BACKGROUND. Plain white paper has many draw-backs. A slight overexposure "fills" the letters, making them hard to read, while the light background lacks elegance if completely plain.

A light colored, patterned background, on the contrary, allows a large margin and produces a pleasing effect. We use a good quality paper that will withstand erasing and which is translucent enough to serve as a guide line.

PHOTOGRAPHING THE TITLE. We use a Siemens titler, capable of many tricks and effects, and is preferable because of its uniformity of illumination.

The technic of shooting the title with the Movikon is very simple, since it is possible to focus on the film. We generally make a complete spool from the title cards of similar size which necessitates framing and focusing only once, following a test previously made of exposure time. It is significant to note that all projectors have not the same gates. Sound projectors, in particular, hide a little of the left side of the frame.

PROCESSING THE TITLE. Positive film is used because of its price, contrast and ease of handling. The only inconvenience is its delicacy, for it swells in hot baths.

We develop the negative in a contrast bath and obtain much better results with a formula without Caustic Soda, prolonging the development to seven minutes without fogging.

ADAPTING THE TITLE. Any amateur has read much about this subject. We will merely say that our titles very seldom contain more than five words. When we have a longer sentence we try to divide it. However, we do not mind a rather long title at the beginning of the film.

DRAWINGS, DIAGRAMS, ETC. Few surgical films are complete without drawings and diagrams. Some are simple drawings, copied by reflected light and some are photographs and X-ray films copied by transmitted light. Many drawings and diagrams are animated. In this case we make a working model of cardboard or thin wood. This is easier than making the hundreds of drawings necessary for a few seconds projection. Only in very simple cases are drawings made, such as when the course of the blood in a bone is to be shown. In this case it is sufficient

to draw a dot for each shot. The models are worked by threads or by animation. The only care necessary is to figure the number of frames required to obtain the proper speed in projection.

ANATOMICAL SPECIMENS present a special problem. Sometimes one is obliged to use positive film, because of its contrast, with a very small aperture for depth of focus. We have even been obliged to use a weak tangential light and an extension tube. As the longest shutter exposure is 1/25 second, it seems impossible to photograph the set. Happily, the Movikon has two ways of giving time exposures: one is with the button that opens the shutter for focusing on the film; the other is with the crank that winds back the film for dissolves. If the crank is run down it is possible to crank forwards at any desired speed.

DUPLICATES. We duplicate films because the original will be subject to excessive editing, or because it will suffer some unsafe procedure, or because we want to "change sides". By this we mean to reverse what is at the right to the left side, and vice versa.

We use an Arri step printer. We could not obtain satisfactory results with a continuous printer. A certain degree of blurring was impossible to avoid. We think it due to the shrinking of the original film in the processing. As the distance between the sprocket holes is different in both films, their speeds are different too. This printer has another advantage: it is possible to make any length of duplicate from a single frame. The frame is fastened with tape to the gate and the positive stock run through the printer. Frequently the duplicate is better than the original because the contrast and density can be corrected. This is so true that frequently we prefer to correct by duplication rather than by intensification or reduction. Also, as we seldom correct any films but valuable ones that can not be taken again, the duplicate is made nevertheless, for fear of spoiling the original.

EDITING. Our objective is to present in each film a complete lesson containing an entire theme: pathological anatomy and physiology, basis and indications of the treatment, technic and results. This makes editing a very important part of the task, if not the most important.

EQUIPMENT AND ROUTINE. This is much a matter of personal taste. Our method has been really simplified by a small apparatus put on the market recently, a film viewer that shows the film in action.

Previously we had to edit with the aid of the projector which is an unpleasant task. As almost all the frames of an operation look alike, it is difficult to place the separations. Since our films are taken with two cameras, each scene is partly in one spool and partly in the other, and both must be united. The new viewer has made it simple for it is possible to slow down the rewinding at the approach of the end of a scene,

stop at the proper frame and punch a hole on the edge. A few inches more are drawn and a number is marked with a dermographic pencil. The other operations are not troublesome. The numbered shots are indexed according to their length and are rolled on a flange and put on the holes of an editing board or pinned to the wooden bar of a film bin. This bin is simply a laundry bag held open by a frame.

Some accessories are useful: a pair of cotton gloves; a pair of enlarging spectacles that allow the vision to be cast through the glasses or beside them; a pair of small scissors, the sort used by assistants at operations, mounted on a ring in order to have them available always; the old model of Bell and Howell splicer is more reliable in our hands than the new one; a cement pen, which is one of the Pelikan Graphos mentioned in the paragraph about lettering, without point and filled with cement; and the rewinders. There should be available as many rewinders as possible, and if handling large reels, include at least one dummy end with some sort of friction brake. The 1600 foot reels are liable to acquire an annoying momentum. It is a convenience to have two splicers, one to make the splice while the other is under pressure.

Somebody said, "Films are not shot but built." The sentence has so much truth in it that its exaggeration can be forgiven. It is a fact that much attention must be put on the shooting, for the best sequences can be ruined in the editing while mediocre film can become excellent on the editing bench. Both factors are important. The surgeon, while doing the operation that is being photographed, must have in mind the final result and act accordingly. Only in that way will he do his work without interfering with the take, giving the necessary time for the scene to be appreciated by the spectator and presenting as clearly as possible the steps of the operation.

Frequently, it is necessary to shorten some parts of a film which become too monotonous, and even to suppress some parts.

Sometimes it is only in the projection of the film that a defect is noticed. The wound might have been closed without allowing enough time to show the final result, showing only two or three frames of it. It will then be necessary to duplicate them, by the method explained in a previous chapter.

At times it is impossible to show some important step. For example, in a film concerning the reduction of a fracture, we were obliged, while correcting the displacement of the fragments, to obstruct the camera view. Thus the film showed only our gestures. To overcome this deficiency we took a dry bone, fractured it, made the movements of correction with the fragments, and shot the scene. The resulting film was cut in pieces and intermingled with the scene of the operation. The

film then showed the surgeon making the gestures, and at the same time demonstrated the correction of the fracture on the dry bone. In this way a series of close ups, showing the details, follows a series of medium shots showing the ensemble. The result was better than if we had taken the details during the operation.

A similar case made us realize the possibilities of cine. It was a film demonstrating the nailing of the neck of the femur. As the operation is performed through a small incision, it is impossible to see how the nail enters the bone. Hence, we shot the nailing process in a dry bone and spliced it on the film of the operation. The spectators' minds are guided by the process of the operation and thus do not associate the idea of the dry bone with that of the patient.

This result suggested another procedure. In the same film there is another nailing procedure in which a bone peg is used. We took an X-ray of the femur, made a cardboard model of the peg in silhouette, and shot by animation a scene in which the peg seemed to enter the bone as seen by X-rays. A few feet depicting an assistant manipulating a fluorescent screen were added and we obtained the illusion that the pegging was being followed by radioscopy.

Sometimes it is even advisable to add secondary details which are not necessary for the development of the theme but are agreeable and hold the attention of the spectator. In an operation in which an X-ray control is done, we showed the take of the X-ray and the nurse removing the film for development. Then we present the nurse in the dark room (shot made in full light with a little underexposure and red tinting). She places the film on the developing tray and a close up shows the image appearing in the developer, obviously, a matter of moving the diaphragm while copying the X-ray on the titler superimposed with a shot of the tray. The film is then brought to the surgeon who views it and decides to close the wound. Thus any student seeing this film will remember that a radiographic control is made before closing the wound.

All the cases mentioned were made for reels of plain operating technic. If it is a complete theme the editing is of greater importance. This kind of film has generally some shots made by animation or models. Let us take our film about the neck of the femur as an example. The first part, titled "Principles", is a memorandum of anatomy and physiology of the region. It begins with an animated drawing in which is depicted the course of the blood in the femur. This was made by adding a dot at each shot. Then it shows how a fracture can cut the blood supply. In this case the same animation was done but with the drawing upside down, hence the lines representing the course of the blood, instead of

growing up, shrink until one of the fragments is left without any irrigation. Then the physiology of the hip joint: its mechanics are shown with a cardboard model of the pelvis and femora, the gluteal muscles being represented by threads.

But we can not continue . . . let us rather consider a point of moral interest. Suppose we want to show, in a film about arthritis of the hip joint, what is known as "the gluteal gait," which is determined by atrophy of the muscles, and we do not have such a shot. Instead we have the same gait but taken from a patient with palsy. Is there any guilt in utilizing this shot? We think there is not in a didactic film the aim of which is to teach. Were the film to be used as a document for research work it is evident that it could not be used. For teaching purposes it is comparable to using schematic drawings in a text book. What would seem to me to be wrong would be, not to take advantage of the possibilities of the cinematograph.

IN CONCLUSION, in regard to editing we realize that we have merely touched on the subject. However, we will try to give a few rules that have proven very useful in our work.

The first rule is to *work a lot on paper.* Even if one has some reels already made, one should make a complete script as if every scene were to be photographed. Also, correct it until it is satisfactory without touching the film. We generally fill small squares of paper with the number and subject of a scene. This permits changing the order as desired until a satisfactory succession is found. *When projecting have the script in hand* noting every observation; do all the cutting with the script and consider each modification in relation with the whole film.

The second rule has been much repeated: *the film improves more by what is cut than what is left.* Study the script and then cut without fear. If you do not arrive at a definite opinion you have the recourse of making a duplicate before cutting.

Work with small reels. Have at hand the complete script but divide the film in definite chapters each one with unity. To work with a long film results in fatigue. Also, if the film is well divided it will be easier for the spectators to follow.

Think that YOU set the pace. In reading a book it is possible for the reader to go quickly to the end, grasp the whole and come back to study the details, rereading any part as many times as he wishes. In a film this cannot be done. The spectator is compelled to follow what is presented before him. Give first a general idea of the matter, divide it into definite parts with a certain unity to each and make brief summaries after complex expositions or use whatever means necessary to follow the development of the theme.

Think of pleasing. Many times the more logical order for a book is not the best for a film. It can be very natural to present first all the explanations and afterwards all the technics but this is frequently boring. It is better to alternate explanations and operations.

Use only photographically good scenes. It would take a genius to make a photographically bad film interesting. It is much better to take out the bad shots even though important, and to replace them by a similar shot, drawing, X-ray or even a title.

Finally—*Do not screen your film before non-medical audiences and do not allow in them the slightest suggestion of personal reclame; do not even give the name of the surgeons.*

BOOK REVIEWS

INTRODUCTION TO ANIMAL BIOLOGY. ***The C. V. Mosby Co., St. Louis, Mo., 476 text pages, 163 illustrations, size 5½ x 8¼. Price $3.75.***

This text is meant to serve as a means or instrument wherewith to teach the student, and to make the study of biology a means to an end. The first chapter deals primarily with the basic or fundamental principles that prevail in animal life. The chapters that follow present a variety of biologic species which differ widely in appearance and structure, in their vital functions, life habits and activities. The text is beautifully and clearly illustrated and concludes with an excellent glossary together with a tabulated arrangement of the chief groups of animals with a brief statement of their principal characteristics. The authors have succeeded in expressing to the student their exposition of facts and principles in a clear, concise and understandable manner.

HANDBOOK OF PHOTOGRAPHY. ***Keith Henney and Beverly Dudley. Whittlesey House, McGraw-Hill Book Company, Inc., New York, London. 871 pages. Prices $7.50***

This is a comprehensive, authoritative and complete encyclopedia of photography in one well organized volume. Twenty-there photographic specialists have cooperated in the preparation of material for this handbook. There are thirty chapters containing scientific discussions and data relating to practically all of the various aspects of the technic of the photographic processes and the scientific basis underlying photography and its applications. Included in the profusely illustrated text are many charts, tables and diagrams which constitute a ready source of valuable information. The subject matter is presented with directness and authority, but at a level which makes it understandable and interesting. Since completeness of source-material, and accuracy in details are obviously a pre-requisite in a book that is to serve as a reference, this handbook of photography should find its way quickly into the library of every serious photographer.

THE CENTENARY OF PHOTOGRAPHY — ITS CONTRIBUTION TO THE BIOLOGICAL SCIENCES*

LOUIS SCHMIDT†

IN A RECENT editorial in The Saturday Evening Post we read: — "The World was blind one hundred years ago. It saw with its eyes, but no longer than the image remained on its retina. If a famous man or a famous scene had not been painted at the time, no one who came after could know what the man, or the scene looked like." They forgot to say that by means of life and death masks and by sculpture records, the appearance of individuals had been preserved.

The richness of our present knowledge, pertaining to all fields of endeavor is so great, that it is impossible for us to realize the extent to which we are indebted to photography for that knowledge. If it were possible to forget every impression that had been made upon our minds by means of photography, and to compare its emptiness, with the fullness of our present information, we *might* appreciate the extent to which we are indebted to this far reaching Art.

Without it, in its single application to the printing press the illustrations of the World would be limited to the work of the artist, rendered into printing-plates by the hand of the engraver on wood and metal, the etcher and lithographer, as it was fifty years ago. The cost of those methods was so great as to be, in many cases, prohibitive. The crafts to which photography is an essential part, are now the major source of supply of the printing plates for illustration, both in black and in color. They are also the means by which most of the originals for those illustrations are produced.

In the motion picture, photography has given us a collossal industry, which besides its function in the amusement field, has given education a new and improved method of teaching, and to science a new tool for research.

It is significant that in the very early days, when there were practically no amateur photographers, scientists were among the first to recognize that this art could be utilized to greatly facilitate their work. In Harper's Magazine of September 1856, there appeared an article: — "On the Application of Photography to Printing." It stated that a number of the new illustrations for Dr. John W. Draper's book "Human Physiology, Statical and Dynamical," were produced by photography instead of being drawn by an artist. However as the process of photo-

* President's message presented at the Annual Convention of the Biological Photographic Association in Pittsburgh on Sept. 14th, 1939.

† Rockefeller Institute for Medical Research.

engraving did not then exist, these new illustrations were, of necessity, engraved on wood for printing purposes.

As an example of how early it was realized, by some, that photography was to play an important part in the service of the Medical Sciences, it is noteworthy, that in the New York Medical Journal, Dr. Ransford E. Van Gieson wrote in 1860; "And yet there is no science or art, not strictly medical, the cultivation of which will more richly repay the scientific physician. The advantage which would result from the establishment of photographic departments in our various charitable institutions, can scarcely be over-estimated."

One of the first applications of photography to scientific use was its association with the microscope. The probable reason was, that the microscope was a highly developed instrument at the time when photography was born, and it was a simple matter to combine them. The method of arranging them together was quite simple and has changed little. Improvements have come mostly in refinements in photography and in methods of illumination.

Donne presented such an arrangement to the French Academy in 1841 and in 1845 published with Leon Foucault an Atlas containing engravings made from Daguerreotypes that he had made.

In this country between 1865 and 1870 much work was done by Major J. J. Woodward, who reported his results to the Surgeon General on his experiments with various illuminants. Among many others was the one using sunlight controlled by a heliostat. The image was projected across the entirely darkened room to the plate which was mounted on an easel. The entire room thus constituted the camera. Wet plates were used.

It is surprising that in those early days, before electric light or rapid emulsions were available and even dry plates had not been invented, there were men who had the courage to attempt some of the most difficult of photographic problems — the field of Endoscopy, the visual inspection of hollow organs and the application of photography to them.

Desormeaux devised such an instrument to visualize the interior of the bladder. In 1863 he published a description of the apparatus and of his ten years experience in its use. It consisted of a "sound" with a mirror set obliquely at the outer opening. This reflected a beam of light through the tube which illuminated the inner structures. It was easily adapted to photographic use. Equipped with a variety of suitable "sounds" it could be used in the urethra, rectum and the bladder.

Attempts to use similar methods to obtain pictures of the interior of the stomach resulted in failure. Gastro-photography was impossible

with reflected light. After many futile efforts the problem was finally solved in 1930 when the gastrophotor was invented by Heilper and Borges. This produces eight stereoscopic photographs, covering the entire interior of the stomach, taken with a pin-hole camera in which focusing is unnecessary. The camera is introduced at the end of a rubber tube which also carries the electric light and wire.

Attempts were made to photograph the larynx, by Johann Czermak in 1860 by means of photographing the image in the laryngoscopal mirror. In 1882 this method was superceded by one based on the use of sunlight through a condensing lens, trained on the operator's head-mirror and reflected into the pharynx. In its perfected form the camera was 10½ inches high, 1½ wide and ⅞ inches deep, with a projection lens near its lower end, where a small handle was fixed. Thus the mirror was rigidly fixed in relation to the lens, camera and plate, all moving together as a unit. Five pictures could be made at one loading. Practically a miniature camera before its day. Once it was found that a small camera was preferable, rapid progress was made.

The first, relatively, successful photographs of the fundus oculi were made by Rosenburgh in 1864. This problem is greatly complicated by troublesome reflexes or flares from the cornea and the lens. In 1889 Liebreich devised an apparatus for projecting light from a perforated mirror which was based on an invention of Helmholtz. With this the human fundus could be examined and photographed. The reddish hue of the retina added another problem to good photography, for no color sensitive emulsions were then available. Another great obstacle was the difficulty of obtaining enough light to register the image on the plate without seriously injuring the eyes of the patient. This method was improved in 1893 by Guilloz who focused with a weak light and exposed with a flash. Later, in illuminating the retina Thorner and Dimmer attempted to eliminate flares by projecting a beam of light through a portion of the pupil, leaving the central part for photographic purposes. This principle, finally perfected in the Nordensen Camera, has practically eliminated flares and made possible the beautiful photographs of fundus oculi of the present day.

Photography in the printed literature, including scientific books and periodicals, could not come into its full flower while it still depended on hand-made printing plates. Only after the invention and introduction of the half-tone process was it possible to secure printing plates, direct from photographs, as well as from paintings, by a photo-mechanical process. Thus plates were produced quickly, cheaply and accurately, with only a small amount of hand work. This process has been constantly improved by the introduction of better lenses, screens, and meth-

ods of etching. Mention should also be made of photolithography and the photogelatin processes.

There were however some publications which were illustrated with actual photographic prints, the widespread use of this plan was hampered by the restrictions of the manifolding methods rather than by the difficulty of making the originals.

The introduction of photography has made possible the enrichment of all illustrated literature, because it has lessened the cost of the production of the originals as well as the photo-mechanical processes employed in the exact rendering of those originals.

Although Photography was hailed as a great and helpful servant of science eighty years ago, its use did not make rapid and continuous progress. This was no doubt partly due to the fact previously mentioned, that photo-engraving had not yet been introduced and that while manual methods of making printing plates persisted, drawings seemed better copy than photographs. Certainly forty years ago photography was not very freely used. At that time there were engaged at the Medical Department of the University of Pennsylvania, six artists and one part-time photographer.

From that slack period, the present high interest and appreciation has grown. Those who carried on from there, excluding the scientists who served themselves, were laboratory technicians, scientific artists and later commercial photographers, each bringing into his craft something of value from his former occupation. Being widely scattered they worked independently, each developing his own technique and learning in the hard school of experience. To these have been added those younger men and women photographers who have chosen to embrace Biological Photography as their life work.

It has been the mission of this Association, in the last eight years, to bring together these scattered workers for exchange of views and discussion of methods, and through its journal to give publicity to the procedures that its members and others have found satisfactory, many of which had formerly been jealously guarded secrets.

We pay tribute to these far-seeing scientists, who so early appreciated the part that the art we practice was to play in the service of the various sciences. We give thanks to the investigators in the optical and supply industries, who are constantly working to give us better instruments and materials with which to carry on our work, so that we may keep step with the ever more exacting demands that will be made upon us.

CURRENT PHOTOGRAPHIC ABSTRACTS

2171-081

A Portable Loose-Sheet Microphotographic Camera. R. H. Draeger. *J. Soc. Mot. Pict. Eng.*, **30**:601-04 May, 1938. A device is described for copying records on 35-mm. or 16-mm. film. A plate-glass window is provided upon which the sheet to be copied is placed face downward. The hinged platen is then closed holding the sheet in place while the exposure is made. A mirror is movably mounted within the case upon an arm at an angle directly below the plate-glass window for directing the light-rays from the window to the camera lens. The use of a mirror in this manner greatly reduces the over-all dimensions of the apparatus and also allows the camera and operating mechanism to be placed in a convenient position at the rear of the head. To provide uniform lighting of the photographic field, a rectangular placement of 6-volt lamps in series has been used; they are turned on only during the exposure interval. The film magazine will accommodate 200 feet of film. The speed of operation is estimated conservatively at 500 sheets per hour.
E. J. L.

263-019

The Computation of Optical Systems. G. Martinez. *Ottica*, **3**:188-203, No. 3, 1938. The author gives a detailed elementary discussion of the color correction of optical systems
M. H.

215-097

Filming within the Human Body. H. Grau. *Photography*, **6**:45, 48, June, 1938. Following a brief description of the Askania camera, which is especially adapted for clinical work, reference is made to a specially designed thoroscope for filming within the human body. The instrument consists of a tube provided at its tip with a tiny electric lamp which is connected to a camera. An observer can examine the image by a lateral control between the thoroscope and the camera, and thus direct the filming.
T. M. L.

K0609

Problems Involved in Full-Color Reproduction of Growing Chick Embryo. E. S. Phillips. *J. Soc. Mot. Pict. Eng.*, **31**:75-81, July, 1938. Development of the chick embryo was shown in three different ways:

through the shell by transmitted light; by removal of part of the shell and the use of reflected light; and by removing the embryo entirely from the shell. A number of difficult optical problems were encountered. Temperature, humidity, and light control were major problems. Special equipment designed to meet the needs of both normal incubation and photography was constructed. Mineral oil was used to obtain a transparent plane surface over the opaque, irregular inner membrane of the egg's air-cell. C. T.

K/44-K/43

How Agfacolor and Kodachrome Were Conceived. J. H. Coote. *Photography,* **6**:26-7, June, 1938. The histories of the Agfacolor and Kodachrome processes are reviewed and their methods of process described. Brief reference is made to Schinzel's work which lead up to the Gasparcolor process. T. M. L.

K/8-K/42

The Eastman Wash-Off Process: Some Practical Notes on Details of Working. P. K. Turner. *Brit. J. Phot.,* **85**:387-89, June 24, 1938. The author outlines his technique for obtaining color prints by the Wash-Off Relief process, and alternative formulas are suggested for the developer, the acid rinse solution, and the mordanting solution. It is stated that when hard water is used, the speed of bleaching may be increased by doubling the quantity of sulfuric acid in the bleaching solution. T. M. L.

The Electron Microscope and Its Applications. Ruska, Borries, and F. Krause. *Umschau,* **42**:766-68, 769-71, No. 34, 1938. A short and simple description is given of the new electron microscope built by Siemons and Halske A.-G. After explaining the principles utilized in its design, the authors describe different applications in the fields of biology and colloid chemistry, and show pictures that have been obtained with the microscope, using magnifications up to 40,000 times. H. E. G.

0185

Simple Sentivity-Increasing. A. Niklitschek. *Fot. Rund.,* **75**:215, No. 12, 1938. With certain lantern-slide and similar low speed, clean-working plates, the author has obtained a doubling of the effective speed, without fog or coarsening of the grain, by leaving the inverted plates after exposure in a box over a small quantity of mercury for 24 hours E. R. B.

2674-059

Polarizing Materials. E. Nahring. *Filmtechnik,* **13**:145-48, No. 13, 1938. A description of various polarizing materials and their properties is accompanied by some details of methods of manufacture and suggested uses. O. E. M.

PHOTOGRAPHIC TECHNIC

F. R. HARDING*

PHOTOGRAPHY IN THE POSTURE AND SCOLIOSIS CLINIC

THE purpose of photographing functional scoliosis and structural scoliosis is to obtain a record of the patient at the initial visit to the clinic and at definite intervals thereafter, usually, once a year unless a marked change suddenly takes place.

Four views are made of these cases: an anterior, posterior, lateral, and posterior in the forward bending position. These are all full length views.

The course of the spine should be marked with a soft black crayon. A black eyebrow *crayon,* not a pencil, appears to give better results than a regular skin pencil. It readily produces a good mark on greasy or moist skin which the skin pencil will not do.

The background and immediate floor area should be black, except when negroes or very dark skinned whites are photographed. A white background should be employed under these conditions. The spinal course of negroes may be marked with a white chalk paste, applied with a small cotton swab. All patients should be photographed entirely nude. A small "T" binder may be painted on the negative with opaque. If a "T" binder is actually worn, it distorts the hip line.

Either two or four lamps should be employed. Four are to be preferred, arranged in pairs one above the other on an adjustable lamp stand. One lamp should be 18 inches from the floor, and the other slightly above the patient's head and directed downward. The lights should be about four feet from the patient. The lower lamp may be fastened into position permanently on the lower part of the lamp stand. The upper lamp requires adjustment for each patient. If only two lamps are available, one must be kept low, to properly illuminate the feet and legs while the other, on the opposite side of the camera, is kept high. A half length white reflector is placed on the side opposite the low light. This will reflect sufficient light to the shadow side of the feet and legs. Care must be used in placing the lights in order to eliminate shadows on the inner margin of the knees, and to keep at a minimum the shadows cast by the arms on the outer margin of the hips. The patient should stand in the normal position with the arms hanging freely at the sides. New patients are frequently nervous and stiffen the arms, raising the shoulder line. This should be watched for and steps

* Received for publication on November 1, 1939. Children's Hospital, Boston, Mass.

taken to correct it before any exposures are made.

The patient's heels *must* be in line with each other during all scoliosis photography. Each of the four views must be a true position. Special care must be taken with the forward bending position to make certain that the body does not sway to one side. The only correct position is to place the patient's back to the camera, knees stiff, with the body bent to the degree necessary to show an outline of the maximum spinal rotation. This point may be arrived at by having the attendant place a finger on the spine at the point of maximum rotation while the patient is standing erect, and then directing the patient to bend forward slowly, with the finger still in position. It is not difficult to find the maximum point by proceeding in this manner. If the body sways to either side, the photograph will be of no value. An equal amount of both sides must be visible. When the lateral view is made, the arms must be in such a position that the anterior-posterior curves of the entire spine will be visible. To do this, the arms must be moved toward the front of the patient just enough to produce the desired result.

Some posture photographs are made in the form of silhouettes, but this method has a number of drawbacks and some orthopedists are of the opinion that it has little or no value.

All functional and structural scoliosis prints are made through the "Invisible Screen." The information necessary for using this screen was published in the "Journal of the Biological Photographic Association" Vol. I Number 4, June 1933. For the benefit of recent members, the screen is a sheet of clear celluloid with fine lines one-fourth inch apart, cut into the surface. These lines run in both directions, breaking the surface into one-fourth inch squares. A true vertical line is marked on the background. The patient stands so that the line shows on the ground glass. The screen is placed on the printing machine, the negative is placed on top of the screen and moved until one line of the screen is parallel to the line showing on the negative. Printing paper is then placed on the negative and the print exposed. The posterior view must have a line passing vertically through the crease of the buttocks, to form a midline, from which, deviation of the spine may be observed more readily than without the screen.

News from the Trade

Information on the new Summitar F 2, 50 mm. High Speed Anastigmaitc lens by Leitz, and the small, high efficiency Gnome II projector may be obtained from E. Leitz of New York by requesting Numbers 1277 and 7838 respectively.

Eastman Kodak Company states that manufacturing operations will not be endangered by any shortage of materials on account of the war. Since the World War of 1914, practically all photographic materials have been manufactured completely in this country. This is a far different situation than that which existed in 1914 when practically all the basic material for photography was imported from Europe. Every effort will be made to maintain the usual price level of photographic materials.

The high speed fine grained Super Pan Supreme emulsion manufactured by the Agfa Ansco Company which has been very popular among motion picture photographers and miniature camera users is now available in roll and pack film. It provides twice the speed of Super Pan roll and pack film which it replaces. The new film provides a notable improvement in fineness of grain and a better balanced color sensitivity. Until new cartons can be supplied for all sizes, some sizes will be supplied in old type Super Pan cartons, either overprinted with the word "Supreme" or with a small label.

Instead of the direct scale giving readings in candles per square foot, the Leicameter readings are in direct shutter speeds. The "High Illumination" scale gives direct shutter speed readings from ½ second to 1/1000 second. In the case of the "Low Illumination" scale, the film speed of Weston 50 has been chosen. The Master Leicameter has all of the Weston features and can be differentiated by an orange band on the face of its calculator dial.

Report of the Committee on Motion Pictures

I. *Publications of Interest.*

Directory of film sources. Victor Animatograph Corporation, Davenport, Iowa. 7th ed. 1939. 50c.

Krows, A. E. Motion pictures not for theatres. *Educ. Screen,* Feb. 1939. One of a series of articles dealing with history and relation to biology.

Medical motion pictures which are approved by the College. *Bull. Am. Coll. Surg.,* 1938, 23:424-440.

II. *British Film Institute.*

The Institute coordinates the film trade, the educational groups and the general public with reference to films for entertainment and instruction. It is financed in part by grants from the Cinematograph Fund administered by the Privy Council and in part by members' subscriptions. The aims are defined to act as a clearing house for information on films made at home and abroad, to influence public opinion to appre-

ciate the value of films, to advise educational institutions and other organizations, to encourage research in the use of films, to establish a national repository of films of permanent value, to provide a descriptive and critical catalog of films of educational and cultural value, to advise governmental departments concerned with films, to certify films as educational, cultural or scientific and to undertake similar duties in relation to the Empire.

Their 1938 catalog lists the following number of subjects: mathematics 14, astronomy 7, physics 57, chemistry 16, geology 11, botany 40, physiology 14, zoology 222, applied science 27 and scientists 9. Twenty-three distributors are listed. Critical notes and evaluations are published in the *Monthly Film Bulletin.* Average rentals run from 1s. 6d. to 5s. per reel per day for silent and 5s. Od, to 7s. 6d. for sound. (37c to $1.90)

The Institute's Report on Science Teaching Films (1937) presents a discussion of the problems of the use of films in Great Britain. Their recommendations are of interest to many of our members and are here briefly summarized. Producers are advised against exclusive silent or sound and recommend that sound be used only when essential. Short films of 8-10 minutes are preferred and may be as short as 3 minutes. Only essentials should be included, but too great concentration should be avoided. The teacher is expected to do the teaching and valuable film should not be wasted on purely instruction. Simple experiments can be done by teachers and do not need to be filmed. Costs should be reduced—a film should cost no more than a good book. Films must be authentic and any suspicion of faking is to be avoided. Only those subjects in which movement plays an important part should be filmed. Simple language should be used and the commentary should be delivered slowly. Modern sound technic which allows plenty of silent sections for observation and original thought should be widely followed.

III. *Films by our members reported in* 1939.

Bergman, Lester V. 715 Eastern Parkway, Brooklyn, N. Y. "Ovulation and the effects of the gonadotropic hormone from pregnant mares' serum". (Sound and color). "Development of the tuberculous cavity."

Claff, C. Lloyd, 5 Beal Road, Randolph, Mass. "Phenomenon of excystment of Colopoda cucullus."

Downing, J. G. (M.D.) 520 Commonwealth Ave., Boston, Mass. Motion pictures on fungi. Exhibited at the American Medical Association meeting.

Felsen, Joseph. 120 East 39th St., New York, N. Y. "Hand to mouth."

Two reels 16 mm. on the prevention of bacillary dysentery. Produced under his direction by W.P.A. and under the sponsorship of the Bronx Hospital. Accepted by the Public Health Committee for showing at the World's Fair.

Harding, Ferdinand R. Children's Hospital, Boston, Mass. "Premature infant care." 500 ft. 16 mm.

Heard, Osborn. Dept. of Embryology, Carnegie Institution of Washington, Baltimore, Md. Serial photomicrographs of embryological research on 35 mm.

Lown, Wilbour Chace. Massachusetts General Hospital, Boston, Mass. "Arthroplasty of the hip." Color and black and white, 1200 ft. A series on gait are in preparation and color is used in teaching of skin conditions.

Perkins, Earle B. Rutgers University, New Brunswick, N. J. "Amphibians of New Jersey." Instructional pictures in biology, medicine and surgery.

Roger, Henry. Sandy Hook, Conn. Films on carbon for Cabot Co., Boston; various biological subjects for Erpi; industrial subjects for Phonovision, Inc., N. Y.; skin conditions for Federal Trade Commission; photomicrographic research on carbon, rubber, paint, textiles, etc.

Schiller, Dr. A. E. 419 Professional Bldg., Detroit, Mich. Color motion pictures of skin diseases.

Mr. Bergman is writing up his methods for our *Journal* and Dr. Schiller's article is to be published in *Arch. of Dermatology.*

Members are requested to send titles of their films or of publications on motion pictures to the Secretary or to the Chairman for publication in future reports.

OSCAR W. RICHARDS, *Chairman*
19 Doat St., Buffalo, N. Y.
K. K. BOSSE
JEAN KIEFFER

AN OMISSION

In Julian A. Carlile's article, "The Photography of Experimental Plants in the Studio," Jour. Biol. Photo. Assn., 7, 59-63, December, 1938, credit for design of the studio stage described in the article, was inadvertently omitted. This studio stage was adapted from one designed by Louis P. Flory, Boyce Thompson Institute for Plant Research, Yonkers, New York.

ASSOCIATION NEWS

THE PITTSBURGH CONVENTION

DELEGATES from 15 states and Canada attended the Pittsburgh Convention. All meetings were held in the auditorium of the Mellon Institute for Industrial Research, with the Salon and Technical Exhibits in opposite rooms close-by.

The following officers were re-elected:

Louis Schmidt ---------- President
William Payne ---------- Vice President
Anne Shiras ---------- Secretary
Stella Zimmer ---------- Treasurer

Jean Kieffer, Norwich, Conn., and F. R. Harding, Boston, Mass., incumbents, and Dr. A. W. Proetz, St. Louis Mo., were elected to the Board of Directors.

Milwaukee, Wisconsin was chosen as the 1940 convention city by the association.

The Salon, with work from seven states and Canada, was smaller this year than last. Several of our regular contributors were missing this year, which was to be regretted. On the other hand we had some newcomers, and an unusual amount of flower, animal and other natural history pictures.

The Jury adopted a rigorous policy of not hanging prints from any one exhibitor which duplicated each other in type of material and technique used, and this further cut down the number of pictures. Space was reserved to the very end of the Convention for the exhibit of some two dozen scientific pictures to be contributed by the Royal Photographic Society, though there was slight hope of their reaching us. We can only hope that they will volunteer another exhibit in some more peaceful year.

The photomicrographic competition, after many viscissitudes, was shown this year. Failure to comply with specifications disbarred two entries; one showing prints at other than the required magnifications; the other failing to report the technique used. We hope that in future competitions, several of which were suggested at the business meeting, all who make the effort to compete will also take the trouble to read the requirements thoroughly.

1939 SALON AND PROJECTION SESSION

Prints from the following exhibitors were accepted and hung in the Salon:

The American Institute
Science & Engineering Clubs
60 E. 42nd Street, New York, N. Y.

G. L. Henneman
Bureau of Mines
Pittsburgh, Pa.

Devereux Butcher
Lumberville, Pa.
Julian A. Carlile
Rockefeller Institute for
Medical Research
Princeton, N. J.
Theodore Catelli
Rockefeller Institute for
Medical Research
Princeton, N. J.
Cornelius Denslow
Brooklyn Children's Museum
Brooklyn Ave. & Park Place
Brooklyn, N. Y.
C. G. Eddy
Eloise Hospital
Eloise, Michigan
Robert A. Sage
Baylor University
Dallas, Texas
E. P. Haddon
4003 Marathon Street
Austin, Texas
Ferdinand Harding
Children's Hospital
Boston, Mass.
H. S. Hayden
Montreal Neurological Institute
Montreal, Canada
Wilbour Chace Lown
Massachusetts General Hospital
Boston, Mass
E. B. Mains
University Museums
Ann Arbor, Mich.
Adolph Marfaing
Institute of Ophthalmology
Columbia University
New York, N. Y.
William W. L. Martinsen
1840 N. Mason Avenue
Chicago, Ill.
William Payne
State Institute for the Study
of Malignant Disease
Buffalo, N. Y.
Reinhardt Rosenberg
Department of Anatomy
University of Pittsburgh
Pittsburgh, Pa.
M. G. Schneckenburger
East Aurora, New York
Science Service
Washington, D. C.
Stella Zimmer
School of Medicine
Syracuse University
Syracuse, N. Y.

During the projection session, slides and films from the following contributors were shown:

Chester Henry
Falk Clinic
Pittsburgh, Pa.
J. G. Howard
Medical School
University of Otago
Dunedin, New Zealand
Miriam Kase
43 Center Street
Danville, Pa.
Albert Levin
Montefiore Hospital
Pittsburgh, Pa.
E. B. Mains
University Museums
Ann Arbor, Mich.
Florence Melvin
Ohio State University
Columbus, Ohio
Henry W. Morris
University of Minnesota
Minneapolis, Minn.
William Payne
140 Stockbridge Street
Buffalo, N. Y.
M. G. Schneckenburger
East Aurora, New York
Wendell Shields
Erpi Classroom Films
Long Island City, N. Y.

MARCH OF PHOTOGRAPHY SESSION

The Pittsburgh Convention was characterized by more informal discussion than we have formerly allowed time for. The session on the *Scientific Photographic Department* will form the nucleus for further written discussion among members, and will eventually be organized into a folder or pamphlet of advisory material for those who are beginning new departments or reconstructing old ones.

"The March of Photography" meeting was designed as a discussion of new materials between members and manufacturers, from the point of view of biological photography. Unfortunately it is impossible to report this session in full, but a brief abstract is given below of the new products presented.

Agfa Ansco Co., Binghamton, N. Y. Mr. Lloyd Varden discussed the following new materials: *Mini-pan* film, a panchromatic emulsion for mini-copy work, strikes a careful balance between steepness and softness, so that it handles both line copies and tone copies, as well as small museum objects, antiques, gross objects, etc. It has a resolving power of 3500 lines to the inch, which renders it suitable for the copy of newspaper sheets on 35 mm. frames for projection in reading devices.

Triple S Superpan Reversible Film, is a reversible film with the speed of the fastest negative film. It has Weston ratings of 100 in daylight and 64 in Mazda. Mr. Varden stressed the fact that contrary to popular opinion the new high speed emulsions do not necessarily show more graininess than previous films. Present speed standards of 100 in daylight and 64 in Mazda (Weston ratings) are being maintained often with reduced graininess, and with other desirable characteristics fully embodied in the films.

Cykora Papers show a decided forward advance in having an exceptionally long straight line in the characteristic curve. Within the scale of the paper they translate the density separation of the negative in a true likeness.

Brovira Mapping Special contains a change, not in the emulsion but in the paper stock itself. It is a mapping paper with very low shrinkage characteristics. Ordinary paper is not suitable for mapping because even though a correlation curve is drawn to correct for shrinkage, it would apply only to certain humidity and temperature conditions. This new stock, shrinking in only one direction to any extent, is sufficiently controllable for many accurate measurements that formerly were not possible.

Agfa-Light. This new folding unit was displayed in the commercial exhibit. It is very portable and can be taken out on location for any

sort of photographic work of gross subjects. It is mounted on wheels and so can conveniently be pushed around a smooth floor. Its height is adjustable up to nine or ten feet. The two reflectors have a diffuser in front and a pantograph arrangement for holding them in any desired position. The price is $25.00 without lights, and it has extension sockets that can be incorporated for different types of photofloods.

Bausch & Lomb Optical Co., Rochester, N. Y. Mr. L. V. Foster reported that in the past the 32 mm. objectives were not parfocal with the 16 mm. objectives. The Bausch & Lomb Co. is now putting on the market a 3.2X, 0.08 N.A. objective which is parfocal with the regular 16,4 and oil immersion objectives.

They have also introduced a 4.3 mm., 1.00 N.A. fluorite objective for securing magnifications of around 500, 600 or 700. Its advantages over the normal high power dry objectives are:

1. The numerical aperture of 1 provides somewhat more resolving power than the regular dry achromatic objectives.

2. Better contrast results from the omission of air between the front lens and the object.

3. It allows the examination of smears under a medium power while usually high power oil immersion objectives are necessary for such examination.

Iris diaphragms can now be placed in any of the modern achromatic, fluorite or apochromatic objectives of focal length less than 16 mm. (by modern is meant those objectives with lenses mounted in cells and pushed in sleeves, not the old types with knurled rings between the front and back lenses). The iris diaphragm must be used with discretion but has the advantages of increasing depth of focus and more or less subduing the intensity of light scattered by the object. The cost of the diaphragms is approximately $5.00 each.

Another item is an achromatic condenser of 1.5 mm. working distance. The usual achromatic condensers have very short working distances and unless the object slide is very thin, the condenser does not fully illuminate the object. This new achromatic condenser is divisible into three parts, so that it may be used with medium and low power as well as high power objectives.

This company has also recently put out a revolving nosepiece in which the apertures are precentered as well as parfocal. That is, it is not necessary to take the pains to know into which aperture one screws an objective, in order to be sure it is centered. The nosepiece is so machined that one can place any objective in any aperture and have it centered as well as parfocal with the other objectives.

The tungsten arc lamp which was on display in the commercial

exhibit, was built from the principles of the well known sun arc, except that the sun arc uses two ring electrodes, while this lamp uses a solid rod as the anode and cathode. It glows with a white heat and furnishes a homogeneous and circular spot of light for use in photomicrography.

Eastman Kodak Co., Rochester, N. Y. Mr. C. G. Brownell began by calling attention to the new data booklets recently made available on Eastman photographic material. The titles are "Kodak Films," "Eastman Photographic Papers," "Wratten Filters," and "Kodachrome Photography in Color." The first three sell for fifteen cents each, the one on color for twenty-five cents. All give comprehensive data on characteristics of sensitive materials which have hitherto not been available to photographers in general.

A new Cine Kodak folder is also available, free of charge, through the dealers giving movie-makers compact advice and four useful exposure tables for the four most-used types of lighting for indoor filming with daylight, daylight and Daylight Photofloods, regular Mazda lighting, and Photofloods in Kodaflectors.

Duplication is now possible in 35 mm. professional cut-film and 16 mm. kodachrome, which means that color originals can be stored in a safe place and the duplicates used for projection.

The new Eastman Tri-X Panchromatic is announced as seventy-five per cent faster than Eastman's high speed Super XX Film, finer in grain than Super Sensitive Panchromatic and almost as fine-grained as Eastman Super XX Professional Sheet Film. Its price and range of sheet film sizes is the same as Eastman Portrait Panchromatic.

Eastman Ortho-X, a fast, moderately fine-grained orthochromatic film, matches the Portrait Super Speed Ortho Antihalation in general gradation and quality, but is 2½ times as fast, with finer grain. The prices and size range are the same.

Both films are on Safety-Base. To realize maximum speed from either emulsion, development in DK-60a is recommended. DK-50 is also a satisfactory developer.

In the 16 mm. field, Cine-Kodak Super-X Panchromatic is announced as a fast fine-grained film, with speed eqqual to that of Cine Kodak SS Pan, better definition, improved quality both in contrast and the rendering of high-lights, capacity to produce superior results, outdoors and indoors, under widely varying light conditions. Exposure recommendations and filter factors for Cine-Kodak Super X Pan are the same as those for Cine-Kodak SS Pan The new film (not to be confused with the former 35 mm. Kodak Super-X for miniature still cameras) is available in 100 foot rolls for $6; 50-foot rolls, $3.25; 50-foot magazines, $3.50; 200-foot rolls, $12; 50-foot Packette, $3.50;

10 meters for Kinamo S-10, $2.50.

A new Kodaslide Ready-Mount Changer, announced as a smooth magazine-feed for the Kodaslide Projector, Model 2, will be available in April. Up to fifty ready-mount slides may be placed in the supply magazine at one time, and the operator may then stand or sit comfortably at a moderate distance from the projector and show the complete sequence without once taking his eyes from the screen. This is a great advantage when the lecturer is his own projectionist.

Mr. Brownell closed his discussion with a demonstration of the new Kodak Precision Enlarger. This apparatus is adaptable to direct photography, copying, titling, photomicrography, production of enlarged prints, lantern slides, film positives, color separation negatives. It has available a variety of accessories and two series of interchangeable projection lenses in three focal lengths. With the system of interchangeable lenses the Enlarger conveniently covers a range of negative sizes from 35 mm. up to 2¼ x 3¼ inches, permitting the making of 11 x 14-inch and larger prints on the baseboard from any negative within this size range. With the enlarger head turned to horizontal position, range of enlargement is limited only by the length of the projection room.

The range of accessories and possible fields of work covered by this apparatus cannot be fully described here. The price, with one No. 212 Mazda Photo Enlarging Lamp and one glassless negative carrier, but *without lens,* is $67.50 Anastigmat lenses are available in 2, 3 and 4 inch lengths at prices ranging from $15 to $20. Kodak Projection Ektars ground to assure optimum color correction and freedom from astigmatism, range from $25 to $35 in 2, 3 and 4-inch focal lengths. Prices on the complete range of supplementary accessories and equipment are available from Kodak dealers or by writing the Advertising Department, Eastman Kodak Company, Rochester, N. Y. for booklet No. 778.

Weston Electric Instrument Corp., Newark, N. J. Mr. Hugh Groves described the following improvements in the new Weston meter:

1. More accurate readings are made possible by having two separate scales for high and low readings, one from 1600 down to 25, the other from 50 down to .2.

2. Film speeds up to 800 are provided for.

3. A narrower viewing angle (30°) provides a more sharply directional reading, so that it is possible to stand beside the camera and measure only the light the camera sees.

4. The calculator dial is more readily movable, having a spring

release which when sprung, permits easy shifting of the dial.

5. The meter, with its sensitive cell in a separate moisture-proof housing, is more rugged, has a longer life and will take harder wear.

6. The new streamlined design is easier to handle.

The cost is $24.00. Leather carrying case $1.25 extra.

New products were also discussed by the Defender Photo Supply Co., Rochester, New York and by the Lamp Division of the Westinghouse Electric and Manufacturing Company, Bloomfield, N. J. Copies of the discussion sent to them for corrections had not been received, however, as this number of the Journal went to press, and will appear in a later issue.

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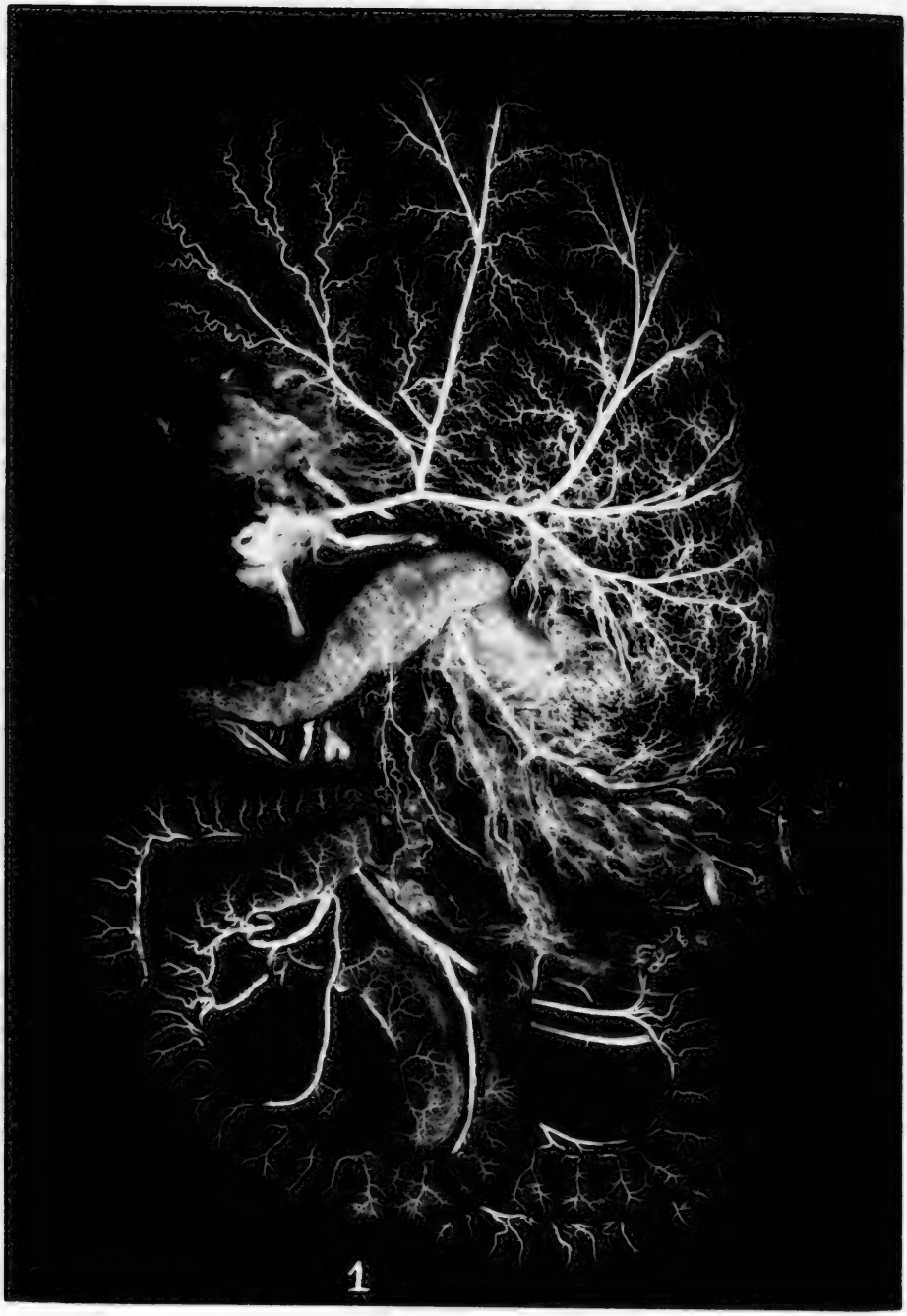

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INFRARED PHOTOGRAPHY AND ROENTGENOGRAPHY OF SPECIMENS INJECTED WITH RED CINNABAR

P. F. SWINDLE*

DOMENICO DE MARCHETTI (1626 — 1688) was seemingly the first person to inject blood vessels[1], but even before his time the vessels were routinely injected by the heart. The blood vessels were apparently made to be injected and the heart was apparently made to inject them. Although the blood seems to be an ideal injection medium in the living body this medium is not highly satisfactory as an aid in determining the architectural features of the blood vascular system in prepared anatomic speciments. However, the injection method used by the heart is undoubtedly superior to a very common one of artificially forcing a selected medium under constant pressure into the arteries. The heart injects the blood rhythmically and under moderate pressures into the vessels. The highest and lowest pressures existing during the cardiac cycle are called the systolic and diastolic pressures respectively. The pulsatile variations in the injection pressure serve to urge the blood abundantly into all of the vessels of the networks of arteries of the body.

Essentially the injection method of the heart is employed in this laboratory to inject the blood vessels of organs and entire animals after

* Received for publication January 25, 1940. From the Department of Physiology of the Marquette University School of Medicine, Milwaukee, Wisconsin.

[1] Gerlitt John: The Development and Effects of Harvey's Theory. Ciba Symposia, June, 1939, 1, 87-93.

EXPLANATION OF FIGURE

Figure 1. Injected and cleared stomach and intestines of a Texas bobcat. Red cinnabar (in water) injected into a common carotid artery. Infrared photograph. Reflected light. Wratten number 87 filter. Exposure 20 sec. Specimens immersed in liquid (methyl salicylate) to avoid highlights. The cinnabar particles did not pass through the capillaries, so that only the arteries became injected.

death. Certain modifications which have been introduced have the condition of the tissues, the nature of the selected injection medium and the purpose of the injection as their principal bases. This method and some of its modifications have been described as occasions demanded in some earlier papers [2, 3, 4, 5, 6, 7]. Those descriptions are more or less fragmentary considerations of the total method which will be presented herein more fully in connection with infrared photography and Roentgenography as means of securing useful records of the specimens and also in connection with Roentgenography as an auxiliary injection method.

A 30 c.c. hypodermic syringe is ordinarily substituted for the heart. It is connected with an artery by means of a glass cannula and a few centimeters of thick-walled rubber tubing. The plunger of the syringe is alternately pushed and pulled to create pulsatile variations in the injection pressure. The artificially created systolic pressure is either not higher or not much higher than the systolic pressure which probably existed in the arteries of the normal animal. The artificially created diastolic pressure is ordinarily much lower, however, than the animal's diastolic blood pressure. The exaggerated pulsatile variations in the injection pressure are created to cause the injection fluid to oscillate sufficiently in the arteries so that every little artery will probably receive at least a small amount of the injected substance. The rubber tube may be clamped with a hemostat whenever the necessity arises to remove the syringe for refilling.

[2] Swindle, P. F.: The Architecture of the Blood Vascular Networks in the Erectile and Secretory Lining of the Nasal Passages. Ann. Ot., Rhin. and Laryn., Dec. 1935, 44, 913-932.
[3] Idem: Perivascular Seep Valves in the Exchange of Body Fluids. Amer. Jour. Physiol., Jan. 1936, 114, 491-501.
[4] Idem: The Principal Drainage Channels of the Eye. Arch. Opthal., March, 1937, 17, 420-443.
[5] Idem: Occlusion of Blood Vessels by Agglutinated Red Cells, Mainly as Seen in Tadpoles and very Young Kangaroos. Amer. Jour. Physiol., Sept. 1937, 120, 59-74.
[6] Idem: Events of Vascularization and Devascularization Seen in Corneas. Arch. Ophthal., Dec. 1938, 20, 974-995.
[7] Idem: Pseudo-arteriosclerosis: A New Pathologic Entity. New International Clinics, Dec. 1939, 4, 39-50.

EXPLANATION OF FIGURES

Figure 2. Noncleared heart and lungs of a fetal calf. Roentgenogram. Red cinnabar (in water) was injected into an umbilical artery while the specimen was very fresh. Cinnabar in the aorta reached the pulmonary artery via the ductus arteriosus. The cinnabar reached the pulmonary veins via the pulmonary capillaries. The injection is much more complete than the Roentgenogram suggests.

Figure 3. Same specimen as for figure 2, but after it was dehydrated and cleared. The photographic technic was the same as for figure 1. The specimen shrank when it was dehydrated.

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If India ink is selected as the injection fluid one may choose to wash the vessels free of blood before beginning the ink injection, but this is only a matter of choice. It is not an indispensable feature of the technic. If the blood is fluid in the vessels the ink can be mixed with it to make it black, or, if the blood has coagulated in the vessels, time should be allowed for the clot to shrink so that it may be blackened by urging the ink between the coagulum and the walls of the vessels. It is possible, by the last method, to keep the ink principally or entirely on the arterial side because the coagulum in the capillaries is continuous with a coagulum in the tissues and does not permit the ink to pass through the lumens of the capillaries to reach the veins.

If red cinnabar (red mercuric sulfide, in water) is selected as the injection medium this substance should likewise be injected rhythmically and under low pressure but into arteries which contain either no blood or fluid blood. The cinnabar drives the fluid blood through the lumens of the capillaries and into the veins. It is well to open one or more of the large veins so that the blood and also the water injected with the cinnabar can escape from the blood vascular system. The cinnabar ordinarily goes only to the capillary bed because the particles of the substance are somewhat too large to pass through the lumens of normal systemic capillaries. It is possible, therefore, to inject first some India ink into the arteries and then to push the ink into the capillaries and veins by injecting cinnabar through the same arterial cannula. This differential injection of the blood vessels is a very convenient one in so far as the black photographs as black and the red photographs as white when infrared photography is used with reflected light. The contrast obtained in the photographic prints is often remarkably sharp. One can also urge the cinnabar through the capillaries and into the veins by first injecting acidified water (a six to ten percent solution of hydrochloric acid) rhythmically into the arteries. The acid diminishes the elasticity of the capillary walls and the tissues about the capillaries and pushes the inelastic capillary walls against the inelastic perivascular tissues so that the lumens of the capillaries become and remain large enough to permit the cinnabar particles to pass through them when the cinnabar injection is later made.

There are various reasons for packing the cinnabar. One is that the packed substance does not escape readily from vessels which are intentionally or unintentionally cut when the specimen is dissected at a later time. Another reason is that the cinnabar particles are so heavy that they settle on one side of a vessel if the substance is not packed.

(These particles do not adhere to the walls of a vessel to the extent that the ink particles do). Another reason is that the packed substance prevents abnormal shrinking of the vessels when the specimen is later dehydrated and cleared. Another reason is that the cinnabar is very radiopaque if it is packed firmly enough in the vessels. Another reason is that the injection of the small arteries becomes more and more perfect during the process of packing the cinnabar. Still another reason is that, during the process of packing, more and more cinnabar is urged into and through the persisting arteriovenous anastomoses in the body or organ so that these can be unmistakably identified in the cleared specimen.

In order to properly pack the cinnabar in the arteries the substance is injected many times in the usual manner (rhymically and without using excessively high pressures). The individual injections, of a few minutes each, are separated from one another by pauses ranging from about ten to thirty minutes. The pauses should be long enough for much of the water injected with the cinnabar to escape from the arteries by seeping through the packed cinnabar to reach the lumens of the capillaries and veins. This water can escape from the body if an opening is made in a vein. It is advisable to inject principally water at first and then add more and more cinnabar to the water at later injections until the medium is a cinnabar mud. A final injection of cinnabar in gelatin has been used to bind the cinnabar particles in the arteries, but this procedure has been abandoned for different reasons. For instance, the gelatin shrinks and it also ceases to bind the cinnabar particles when the specimens (including the gelatin) is dehydrated preparatory to clearing it.

In my judgment red cinnabar (in water) has some special advantages or merits as an injection medium. Some of the advantages are that it does not flocculate or undergo any other undesirable change in the vessels, it is radiopaque, figures 2 and 4, it can be urged through the arteriovenous anastomoses in the body[2], it does not pass through the lumens of capillaries, figure 1, except in certain pathological tissues[7] and the consolidated or atelectatic fetal lung, figures 2 and 3, its color is such that it is conspicuous in the vessels, and it photographs as white

EXPLANATION OF FIGURE

Figure 4. Noncleared alligator. Roentgenogram. Red cinnabar (in water) injected into a common carotid artery. Only the arteries became injected. The arteries were found to be much more completely injected than the Roentgenogram shows them to be.

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when infrared photography is used with reflected light, figures 1 and 3.

The radiopacity of the cinnabar makes it possible to use Roentgenography as an auxiliary injection method. Although it is the case that after many years of experience in making injections I am able to determine by the feel of the syringe plunger whether the cinnabar is entering the arteries well or poorly, a more reliable method is that of obtaining Roentgenograms of the organ or animal either while the injection is in progress or after it has been judged to be complete. If the larger arteries show up distinctly and many of the very small ones are detectable in the Roentgenogram the probability is great that the injection is perfect enough that either the greater number of all of the arteries contain enough cinnabar that they will show up clearly in an infrared photograph taken after the specimen has been cleared.. This auxiliary method is regularly used when the specimens are especially valuable because of their scarcity or any other reason. Incidentally some of the Roentgenograms are especially interesting and instructive records of the specimens.

The infrared photographs often have a close resemblance to the Roentgenograms, but infrared photography can be in no sense of the word an auxiliary injection method. No hidden detail seems to be revealed in any of the many infrared photographs and photomicrographs of my cleared and noncleared specimens. Roentgenography, unlike infrared photography, reveals hidden details (as in noncleared specimens), and it is, therefore, a useful auxiliary injection method.

For my own purposes infrared photography is generally more useful than ordinary photography for obtaining permanent records of the specimens because red shows up as white, gray shows up as gray and black shows up as black when the infrared plate is used with reflected light. It is also possible to use a combination of reflected and transmitted light to obtain some fascinating contrast effects from differently injected specimens. This and some other interesting and useful applications of the infrared technic have been presented in some papers by Massopust [8, 9, 10].

The effect of three-dimensionality in some of the infrared prints is very striking. This is especially true when cinnabar only has been injected into the vessels. It can be appreciated in figures 1 and 3. Reflected light fell upon the lungs, figure 3, and the somewhat reddish intestines, figure 1, from all sides so that shadows were reduced almost to an ir-

[8] Massopust, L. C.: Infra-red Photography in Anatomy: Some Experimental Observations. Anat. Rec., Dec. 1934, 61, 71-79.

[9] Idem: The Use of the Infra-red Plate in Photomicrography. Jour. Biol. Photographic Assn., Sept. 1936 5, 20-24.

[10] Idem: Infra-red Photography of Gross Anatomic Speciments. Arch. Pathol., Jan. 1937, 23, 67-70.

reducible minimum. Faint shadows were still present as a result of the incomplete cancellation of them by the lights on the opposite sides of the specimens. Each of the faintly shadowed areas, photographed as a series of brightnesses, contributes to the three-dimensional effect similarly as shadows in ordinary life contribute to the perception of space in three dimensions. The effect can be enhanced by photographing either gross or microscopic cinnabar specimens while they are illuminated principally from one side. By this means individual vessels filled with cinnabar can be made to seem to stand out in bold relief in the photographic print. The shadow effects, as they appear in the infrared prints of various specimens, enable one to judge correctly whether a red vessel passes underneath or above another which it crosses. Such an unmistakable perception of the relative depths of the two vessels in the tissue is not possible when the photograph is obtained by using infrared photography and transmitted light so that all of the vessels are equally black and shadows are not cast.

SUMMARY

1. The heart was the first to inject blood vessels. It injects them under low pressures but in a rhythmical manner so that the injection medium (the blood) is urged in abundance into all of the numerous systemic arteries. The method of the heart is used, with certain modifications which were described, to inject such media as red cinnabar and India ink into the vessels of dead animals.

2. After India ink is injected into the arteries this fiuid may be urged into the capillaries and veins by injecting red cinnabar (in water) into the arteries. With the advent of infrared photography this differential injection proved to be a very fortunate one because the red photographs as white and the black photographs as black when the infrared plate is used with reflected light. Infrared photography (with reflected light) is also very useful in obtaining permanent records of specimens in which the vessels have been injected with red cinnabar only. For instance, the effect of three-dimensionality is unusually conspicuous in the infrared prints.

3. The particles of the red cinnabar are somewhat too large to pass through the capillaries of normal tissues except in the fetal lung.

4. The cinnabar is radiopaque if it has been packed rather firmly in the arteries. It is possible, therefore, to use roentgenography to determine the completeness of the injection of the arterial system. In order to pack the cinnabar in the arteries satisfactorily the injection must be interrupted at intervals to permit the water injected with the cinnabar to seep into the lumens of the capillaries and veins.

THE RANGER SERVES

RAYMOND GREGG*

"RANGER, where can I take a picture of a Bighorn?" "Does this high elevation affect the exposure?" Such questions are becoming common in the lives of our National Park rangers since photography has become an almost universal hobby of out-of-doors people. Within a few years, photography questions promise to compete with the classic "What makes the geysers geyse?" type of query as the leading demand upon the walking encyclopedia of nature who wear the neat uniform of the National Park Service. And almost as soon, it is probable that a reliable answer will be as easy to obtain as the schedule for Old Faithful's eruptions, or the elevation of Half-Dome.

Few single scenic features in the world compare with Crater Lake in beauty, and consequently in photogenic quality. For several seasons, Park Naturalist John E. Doerr, Jr., of Crater Lake National Park watched visitors expose film by the yard, with varying success, and in the course of events, he and his co-workers were called upon frequently for advice. To simplify and organize a service for photographers, Mr. Doerr initiated, during the 1938 season, an activity known as a "camera caravan." At a published time and place, visitors to the park are lined up in their own cars, and conducted over a pre-determined route, with stops at points of outstanding scenic outlook on the rim of Crater Lake. At each stop, the ranger-naturalist in charge of the caravan, by use of enlargements, placed on an easel, illustrating good, bad, or indifferent composition, is able to point out *in situ* the elements that compose a good picture and the mistakes and errors that detract from the quality of a photograph. Correction filters, exposure meters, and tripods or other mechanical aids which have become almost essentials in the naturalist's working kit are explained.

The public liked these caravans from the start. Now, "dubs" are going home with good pictures instead of wasted film; advanced camera fans have found a new source of information on light, speeds, camera angles, and other subjects of special interest. Success of the endeavor at Crater Lake led to the introduction of photography caravans at Rocky Mountain National Park. Popular response during the 1939 season, with fine results for those participating, indicates that this type of service is practicable in National Parks where roads and good photographic subject matter are coincidental. Naturally, the success of the enterprise is largely dependent upon the ability of the naturalist leader in the field

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Park Naturalist, Rocky Mountain National Park, Estes Park, Colo.

of photography. During the season in Rocky Mountain National Park, where one ranger-naturalist handled all caravans because of his specialized ability in the physics of light, camera technics, and esthetics, the results were gratifying. Other members of the interpretation staff have improved remarkably in ability to do photographic work themselves, and to assist visitors in this field in connection with other duties.

The caravans in Rocky Mountain National Park followed three routes, with schedules rotating between them. Each afforded different scenic subjects, natural features and phenomena, and special subjects. One route was planned especially for wildlife subject potentialities. This varied itinerary was especially desirable in an area where large numbers of visitors remain in the park for a week to two months, and return time and again to take advantage of naturalist-conducted activities.

Supplementing the caravan program, lectures, using lantern slide illustrations, were worked into the evening schedules at intervals, dealing with photography and esthetics, or with specialized subjects such as "Outdoor and Nature Photography," "Wildlife Photography," and "With Color Camera in the Rockies." Supplementing this, programs were arranged with visiting artists and photographers presenting worth-while color moving pictures or Kodachrome transparencies, at which time, audiences were privileged to question the speaker on his methods of photography.

But one should not get the impression that this special phase of public service in the National Parks is the only type of activity being sponsored by park personnel to add to the enjoyment, appreciation, and understanding of the visitor. Each year sees new features added to the already imposing list of interpretation devices and services that have been developed in the National Parks since this type of program was initiated with an unpretentious evening lecture and nature study hiking program in Yosemite National Park, in 1918. If a visitor could spend enough time in the twenty-five widely scattered National Parks in continental United States, Alaska, and Hawaii, he could participate in early morning bird walks; accompany hiking parties for special study of trees, flowers,

EXPLANATION OF FIGURES

Figure 1. In National Parks where good photographic material and roads are coincident, the auto caravan for photography is likely to become a standard service. Photography Caravan in Rocky Mountain National Park stopping at a point offering a splendid composition of Mt. Ypsilon (center distance).

Figure 2. Through radio, listeners throughout the country joined the children in the Rocky Mountain National Park Junior Nature School on a field trip each week during 1938 and 1939 seasons.

Photographs by Courtesy National Park Service.

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geology, or other scientific subjects; go on hikes of half-day or all-day duration; join a group on a moonlight hike to a point of especial beauty; sit with a party beside a pond to observe the activities of beavers; visit flower-gardens where within a few minutes he might observe species of plants from every type locality within the park; join in community singing, question bees, or campfire and lecture programs; visit museums where absorbing scientific stories are simplified and dramatized through exhibits and scheduled lectures or conducted trips; go on seven-day pack trips through high-mountain country of supreme beauty and interest; drive along with caravans over fine roads to enjoy scenery in general, or to further his interests in special studies such as geology, ecology, and wildlife; take boat trips for study of marine life and shoreline biology and geology; hike along the rim of a volcanic firepit where fountains of molten lava rise in striking display; walk along easy trails in the bowels of the earth where dazzling displays of stalactites, stalagmites, domes, curtains, and other striking formations of limestone caverns all but stupify the senses with their beauty and profusion; learn the lore of the skies at a "star gazing"; follow self-guided nature trails arranging a schedule of stops at labelled points of interest; stop at roadside shrines which tell with museum technique a scientific story of some natural feature occuring there; climb peaks that afford unsurpassed views; visit glaciers to learn the working ways of ice; or enjoy a discussion with one of the uniformed and informed men who always answer to the oft-heard call: "Oh! Ranger."

In two of the National Parks it is possible to go to "school." Yosemite National Park is the setting for the School of Field Natural History, conducted each summer. Twenty selected persons, usually fourteen men and six women, who have fine background of college training in natural sciences, are accepted as "pupils." Under leadership of technical staff experts of the National Park Service, and scientists from the University of California and other institutions and agencies, the "students" spend two months in laboratory and field work, studying natural sciences of the Sierras, doing one piece of new geological and biological reconnoissance on a selected area each year, and rechecking continued scientific observation projects from other years. From the "graduates" of this school, many of the employed ranger-naturalists serving in the national parks have been selected. In addition, Yosemite National Park conducts a "Junior Nature School" for children of park residents and visitors, with games, hikes, and craft activities being used as media of promoting interest in and knowledge of natural history and the out-of-doors.

The "Junior Nature School" idea was carried out with the same type of program beginning with the 1939 season in Rocky Mountain

National Park. To care for older boys, and those who had completed the training offered in the Junior Nature School (because hundreds of families return year after year to vacation in this park) an organization called "Nature Scouts" was formed in 1939 at Rocky Mountain National Park. By meeting established requirements in outdoor ability and knowledge, the boys may earn the degrees of Pathfinder, Trail-Blazer, Hill-Topper, and Mountaineer. To attain the highest degree normally would require two or three summers of participation in the program. A similar program of outdoor craft pursuits for girls is a projected development of the naturalist services.

Through the Junior Nature School at Rocky Mountain National Park, a new line of usefulness has been opened up to the naturalist staff. For the past two years, weekly broadcasts over the Red Network of the National Broadcasting Company have carried the National Park atmosphere, and the colorful story of the trailside to listeners throughout the country. Field microphones actually follow a group of children on one of their hikes, where the unrehearsed, ad-lib discussions of the children with the author are picked up for the benefit of radio audiences which accompany vicariously the field party. This program, released under the title, "Nature Sketches" has had a splendid reception. In 1938, some seven hundred mail responses were received; in 1939, this response reached almost three thousand. Present plans call for indefinite continuance of this program each summer, with some possibility of it being started early enough in the spring to be used in schools where radio supplements classroom work. Thus, the services of the National Park Ranger have gone beyond park boundaries into the very firesides, yes, bedsides, of the nation. And these listeners are "following through." Many of them have taken up hobbies introduced to them on this program; others have come to the park from distant points to see and enjoy first-hand the things they have heard discussed on the radio; others have brought their children to participate in the Nature School, which is a free service, as are all of the naturalist activities. One listener, an inmate of an eastern penitentiary, wrote expressing his appreciation for the new interests opened up for him by this program.

Thus, education, research, interpretation, popularization of nature study, continue and grow in stature as functions of the men who are administering our great National Parks. The program is plastic, alive, and alert to new avenues for making American wilderness more meaningful for Americans and visitors to America.

COLOR PHOTOMICROGRAPHY OF BIOLOGICAL SPECIMENS*

GEORGE L. ROYER and MARIE E. WISSEMANN†

IN RECENT years the advance of color in photography has been rapid. The development of new and the modification of older methods of color photography have been partially responsible for its increased use. These changes made possible better reproduction of natural colors on film, thus enabling one to record subjects, in their original color relationships, for subsequent detailed observation. Furthermore, the complicated preparation and processing of the film now being done by the manufacturer, has simplified the operations of the photographer.

In biology, color serves many purposes, one being the differentiation of structure. In making detailed structural studies the color which is found naturally is employed, or, what is more frequently the case, stains are used. The histologist has developed this technique to a high degree, preparing stained specimens which sharply and clearly emphasize fine details when mounted and examined microscopically.

It is often desirable to study a particular portion of a specimen under the microscope a second time, or to refer to it occasionally after the original observation. If the structure is small, such as a cell or group of cells, much time may be spent in finding it. A picture of the structure, taken in color, is a permanent record, emphasizes the desired details, and is easily accessible. A group would be able to observe the specimen at the same time, thus eliminating repetition of explanation. The color photomicrography of biological specimens is described in this paper.

APPARATUS

a. *Photomicrographic Set-up.*

The Leica photomicrographic apparatus (Micro Ibso attachment for Leica) was chosen for the work because of its adaptability to any microscope, simply by the removal of the eyepiece. The use of 35 mm. film was desirable because it could be readily and economically obtained. The Leica apparatus, figure 1, consisted of a 10X eyepiece which was placed in the barrel of the microscope. On top of the eyepiece and connected by a collar was a prism arrangement with a viewing and focusing eyepiece. A Compur shutter was located above the prism and was used for making the exposures. The Leica camera, with its lens

* Presented at the convention of the Biological Photographic Association at Philadelphia, Pa., September 1938.

† From the Microscopic Laboratory, Calco Chemical Company, Inc. Bound Brook, N. J.

removed, was screwed into position on the top of the apparatus and was used on time exposure in the usual manner.[1]

b. *Microscopic Exposure Meter.*

An exposure meter was used to regulate the amount of light necessary for a given time of exposure or to determine the time of exposure for a given illumination. It was especially desirable for reversible color photographic processes because variation in the processing of color film is not readily changed to correct for over or under exposure.

The photocell exposure meter consisted of two essential parts, figure 2, namely, the photocell in a suitable holder, and the meter for reading the current generated.

The "Electrocell"[2] was the photocell finally used. The current of this cell was found to be reproducible and was more than three times that obtained from other cells which were tried. The holder for the photocell was similar in construction to that used to fasten the Leica photomicrographic attachment to the microscope. A 10X eyepiece was used and the photocell was located above this at a distance such that the cone of light from the eyepiece filled the front of the photocell. A smaller, less expensive photocell than the one used would probably be just as satisfactory if located closer to the eyepoint.

The sensitivity of the meter depended upon the intensities that were to be measured. In this set-up, a Weston Model 440 meter with a sensitivity of 0.25×10^{-6} amperes per division was satisfactory. An external damping resistance of 800 ohms was connected across the terminals of the meter for critical damping. This made the meter reading, with the No. 1 button depressed, just one-sixth as sensitive as when the No. 2 button was depressed. All readings are given in terms of divisions with the No. 2 button depressed.

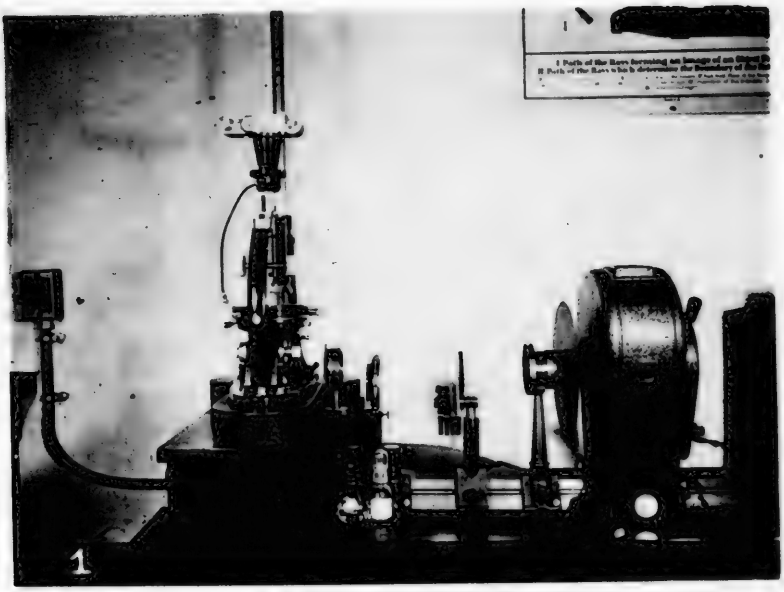
EXPERIMENTAL

a. *Calibration of the Exposure Meter.*

The light intensity was shown to be directly proportional to the meter reading by the use of the inverse square law. The photocell in its holder with the 10X eyepiece was mounted on an optical bench and readings were obtained as a light was moved definite distances away. These distances plotted against one divided by the square root of the meter readings gave a straight line. The intensity of the light was in

[1] At the meeting of the B.P.A. at Philadelphia, at which this paper was presented, it was learned from Mr. Zeiler that the rotating copying attachment method of photomicrography was better adapted for certain types of work. The photocell method described in this paper has also been adapted for use with this apparatus.

[2] 1⅛ inch surface advanced type mounted in Bakelite casing No. 735 Dr. F. Loewenberg, 10 East 40th Street, N. Y. C.



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the range which would be used in practice. This linear relationship proved that the meter readings were directly proportional to the light intensity.

Preliminary exposures on a black and white film of the same speed rating as Kodachrome Type A showed that the exposure for 1/10 second would be an intensity giving a reading of about 25 divisions.

Since the Weston Exposure Meter has been so successfully used for macro photography it was decided to use its calculating disc for the microscopic exposure meter. The calculator was set for a film speed of 12, the value given by Weston for Type A Kodachrome in tungsten light. Setting the arrow at 25 gave an f value of 6.3 for 1/10 second exposure. Kodachrome photomicrographs of a selection of Homo pancreas were made on the Leica set-up with a 10X objective using 1/10 second exposures at meter readings of 16, 20, 25, 32 and 40. These values represented both over and under exposures of the preliminary value of 25, determined on the black and white film. The 25 value was also found to be the best of the Kodachrome exposures. Therefore, the f number of 6.3 on the calculator was taken as an arbitrary value to be used in the determination of time and light intensity relationships.

To check the use of the Weston calculator with this photocell meter for photomicrography at other intensities, Kodachromes of the same subject under similar conditions were made at 1/10, 1/2, and 1 second exposures at the meter readings indicated by the calculator. There was some variation in the accuracy of the shutter times but the exposures obtained were satisfactory.

If the exposures shown by the Weston calculator do not give satisfactory results as shown by tests, then corrected meter values can be determined and established for various times of exposure.

To show that this photocell set-up gave satisfactory results at other magnifications, exposures were made with 20X and 40X apochromatic objectives in place of the 10X used above and at a light value of 5 with a 1/2 second exposure.

It should be mentioned that the readings obtained by this method were the average for the entire field and it was necessary to use judgment when the entire field was not filled with the structure for which correct exposure was desired. It is suggested that in such cases, the percent transmission of the detail should be obtained at a high enough magnification to take in the entire section of the specimen. Then the light value should be obtained for a clear portion of the slide and the exposure for the desired portion could be calculated from the latitude of the film and the percent transmission.

b. *Microscope Illumination for Color Photography.*

All of the exposures were made with a Zeiss aplanatic condenser, using 10X, 20X, and 40X Zeiss apochromate objectives and a 10X Leitz Periplan eyepiece in the Leica attachment. A 500 W. Tungsten lamp with suitable condenser system was used to give Kohler type of illumination. A Wratten blue filter 78B was inserted in the system to correct the tungsten color temperature to nearly that of photoflood, the color temperature for which the type A film is corrected. The use of a set of photographic neutral density glass filters and the lowering in the intensity of the lamp by a rheostat were found to influence the final colors obtained on the film so that these means for variation of intensity to obtain correct exposure were not satisfactory. Ground glass filters were used to change the intensity in steps and the required intermediate value was obtained by the adjustment of the iris of the microscope condenser. This condenser adjustment was not to be desired because of its effect on the appearance of the subject but with an assortment of filters, only minor adjustments of the iris were necessary.

EXAMPLES

At the meeting twenty photomicrographs, taken in Kodachrome, using the method just described were projected. Two examples of the data as to the preparation and photomicroscopic details of the original slides[3] presented at the meeting follow:

Hyacinth root tip showing Mitosis

Fixer—Alcohol	Stain—Safranin and light green
Longitudinal section	133X (40X obj.) Exposure 1/2 sec.
Meter 5	

Stratified squamus epithelium from the cushion of a cat's foot

Fixer—P. A. F.	Stain—Haematoxylin and picro-fuchsin
Cross section	67X (20X obj.) Exp. 1/10 sec.
Meter 25	

SUMMARY

A method of color photomicrography of biological specimens is described. This includes a description of a Leica camera with a microscope attachment, and the construction and calibration of a simple photocell exposure meter. Histological specimens, recorded in Kodachrome, illustrate its use.

[3] Prepared under the direction of Dr. Christianna Smith at the Zoology Department of Mount Holyoke College and Dr. John A. Small at the Botany Department of the New Jersey College for Women.

UNDERWATER PHOTOGRAPHY

EDGAR END, M.D.*

THERE is really nothing mysterious about underwater photography. In fact, the only essential difference between taking a picture under water and taking a picture in a studio is that in underwater photography measures must be employed to keep the camera dry. Above water or below, a photograph is produced by light rays which are brought to a focus on a sensitized emulsion by a lens. If the lens is of fair quality, the exposure adequate, and the composition of the picture good, the resulting image should prove entirely satisfactory, whether it is a picture of your favorite dahlia in full bloom or a close-up of the big turtle that lives under the pier. As far as interest is concerned, however, few dry-land pictures can compete with those taken under water.

It is unfortunate that underwater photography is regarded by many people as an uncharted wilderness which can be explored only at great cost by a few gifted individuals. That such is not the case is so well illustrated by the experience of a friend of mine that I cannot resist telling his story in some detail. This man, Dr. P. G. del Valle, is an ardent nature lover and camera enthusiast of San Juan, Porto Rico. One day, while investigating the ocean floor near his favorite fishing spot, he discovered a coral reef so filled with beautiful tropical fish, marine plants, and unusual coral formations that it has become a Mecca for tourists and natives alike, who visit it in glass-bottomed boats. Dr. del Valle, however, was not long satisfied with the view that he obtained from the surface, so he built simple diving equipment and explored the area fully. The beauty he found there was beyond description, and he determined to photograph it at any cost. To do this, he was forced to manufacture his own equipment and to develop his own technique, for then, as now, little of practical value had been published on the subject of underwater photography.

Dr. del Valle began by finding a metal housing large enough to accommodate a camera. This housing had some shortcomings, however, since it was shaped like a bell with the top cut off and hence had both ends open. The smaller opening was soon closed by a glass window and the larger opening by a sheet of rubber held tightly in place by a drawstrap. Through this sheet of rubber, a rubber glove was inserted and cemented at the wrist so that it extended into the interior of the

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housing but would not allow water to enter. For the initial tests of this apparatus, Dr. del Valle placed in the housing the most disreputable old camera he possessed, but he loaded this camera with the fastest film available. After tightening the drawstrap which held the rubber back in place, Dr. del Valle donned his diving helmet and carried the camera in its waterproof housing to the ocean floor with him. He found picture taking with the apparatus a very simple matter. To operate the camera, he merely placed one hand inside of the rubber glove, grasped the camera, held it firmly against the window of the housing, aimed it, and snapped the shutter. By reversing the camera, he could bring the exposure-number window into view and advance the film for the next picture. When the entire roll of film had been exposed, Dr. del Valle came to the surface, already an enthusiastic underwater photographer.

Despite the limitations of his equipment, Dr. del Valle soon began to produce such splendid pictures that a newspaper dispatched a reporter to investigate. When this man was shown Dr. del Valle's pictures of coral, and fish, and ocean plants, he was so impressed by them that he rushed off to write his story without seeing the equipment with which the pictures had been made. The result was that in the paper, Dr. del Valle's camera was referred to as a "two-thousand-dollar underwater camera." Evidently the reporter felt that any camera capable of producing such splendid pictures must have cost at least two thousand dollars! Today Dr. del Valle still finds amusement in the expression of those who ask to see his two-thousand-dollar camera and are shown the battered old wreck with which he made his first underwater pictures. This old camera, however, proved conclusively that underwater photography is within the reach of everyone.

The type of underwater equipment which will prove most satisfactory to the majority of photographers is easily constructed out of cheap and readily available materials. Nevertheless, in the hands of such pioneers in this field as Captain John D. Craig, Hollywood photographer, lecturer, and author of "Danger Is My Business," and Max Gene

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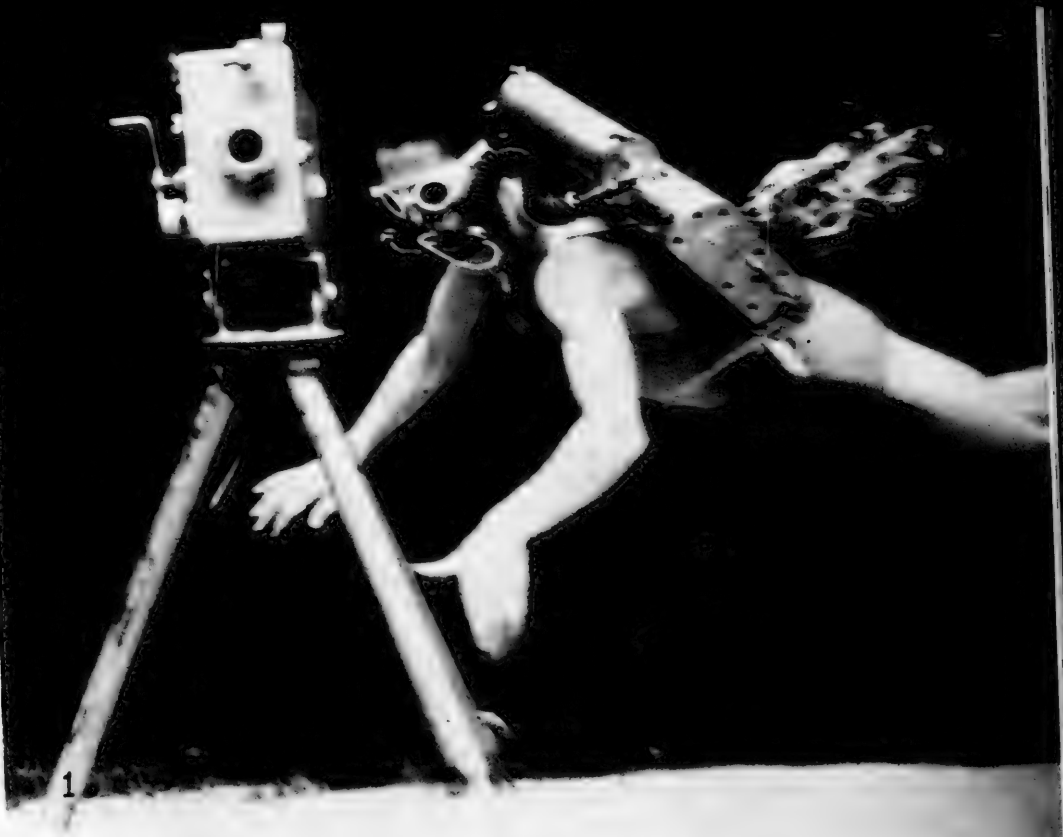
EXPLANATION OF FIGURES

Figure 1. Underwater camera being set up on ocean floor by a swimmer wearing light-weight diving device. The light-reflecting power of a white sand bottom is well illustrated in this and the following figure, both of which were photographed by natural light with a Speed Graphic camera in a metal hydroscope.

Figure 2. By means of the cord which he holds in his hands, the diver is about to start the motor of a moving picture camera, not shown in the picture, in order to photograph his own activities.



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Nohl, lecturer, inventor of diving equipment, and holder of the world record for deep diving, it has produced outstanding still and motion pictures in both black-and-white and color. This apparatus is nothing more than an improved version of the glass-bottomed buckets that are used by sponge fishermen and others to make the bottom visible, and in keeping with its improved estate, it is called a hydroscope, a device for seeing in the water.

To construct a hydroscope for photographic use, it is necessary to construct a long, four-sided, watertight box with a glass window in one end and the other end open. The box is then placed upright so that the open end becomes the top, and in one side near the bottom, another piece of glass is placed to form a window in the side. It may be necessary to add some weight to the hydroscope when finished, to overcome buoyancy, so that it can be extended down into the water without much effort. The size of the device will be determined by the size of the cameras to be used in it, and by the individual tastes of the builder. The materials from which it is made are likewise capable of considerable personal variation, but thin sheets of galvanized iron placed on a light metal frame have proved most satisfactory in our own experience. Soldered joints, windows drawn tightly against rubber gaskets, and the generous use of pitch, white lead, or other sealing material will make a metal hydroscope definitely superior to one built of wood. The top of the hydroscope should always be kept high enough above the water to prevent waves from entering. A good way to test the apparatus for leaks and at the same time to determine if any weight should be added to it is to fill it with water to the point to which it will be submerged, and then to weigh it. Subtract from this weight its weight when empty, and the difference will be the weight of the water it will displace and will give the approximate amount of ballast to add to it for easy handling. When metal weights are used, provision should be made for quickly detaching them so that the hydroscope may be carried without effort.

The hydroscope should be securely fastened to the side of the boat, raft, or pier from which pictures are to be taken, and on any bright day, with the sun high over head and the water clear, it may be put to use. Swimmers in light-colored bathing suits make good subjects for the beginner, but if none can be found to pose under water, a loaf of stale bread suspended in the water will attract an audience of fish in front of your lens in a short time. If possible, photograph your subjects over a white sand bottom which will reflect light upward and prevent dense shadows. Lacking this, an old sail or bed sheet may be stretched on the

bottom and held in place by stones at the corners to form a reflector.

As the first step in taking a picture, a light meter reading should be taken through the side or bottom window of the hydroscope. The visual extinction type of meter may be used by sighting it down the hydroscope at the light coming through the bottom window. As a result of the reading thus obtained, set the diaphragm opening and shutter speed indicator at that combination which will give greatest possible depth of field and still stop the motion met with in underwater subjects. Use the fastest film available, and expose and develop it to give good contrast.

In using box cameras or other fixed-focus cameras, such as most 8 mm. and 16 mm. cine cameras in use today, no special problem of focussing arises. However, when using cameras other than these, or reflex cameras, it is necessary to focus for about two-thirds of the actual distance from lens to subject. This is occasioned by the difference between the refractive powers of water and air, the scale on the lens mount or camera bed having been intended for use in the latter element only. Most reflex cameras are ideal for use in a hydroscope, since they can be focussed without difficulty and exposures made only when the subject is framed on the ground glass. Other cameras must, of necessity, be used rather blindly, their shutters being released when it is judged that the subject has entered a predetermined area in the field.

Most hydroscopes are large enough to permit the operator to extend his hand down beside the camera for aiming it and releasing the shutter. When using such cameras as Rolleiflex, Ikoflex, etc., it is a simple matter to construct a long, slim hydroscope only slightly larger than the camera itself. Such an apparatus is easily managed from the surface, particularly when it is used from a boat, and this is a distinct advantage over larger and more cumbersome hydroscopes. The camera is mounted on a board which slides in a groove in the back wall of the hydroscope, and the camera is lowered and raised by means of this board. The shutter is released by means of a long cable release, and a child's opera glasses mounted at the top of the hydroscope will enlarge the image on the ground glass sufficiently to permit accurate focussing and exposure. With some of these cameras it is possible to focus without raising the camera from the bottom of the hydroscope if levers or other devices are constructed to suit the individual problem.

Artificial lighting for underwater pictures may be employed if desired, but no amount of light will overcome the difficulty of taking pictures in dirty water, any more than powerful headlights will aid in driving through a dense fog. Where electric current is readily available, as on the pier of a lake shore estate, photoflood lamps in metal reflectors

may be employed. The sockets and wiring provided on extension cords for use in laundries and around automobile wash racks are usually sufficiently "waterproof" to be used in shallow water. It is important never to turn on the current until the photoflood lamps are entirely under water, or they will crack. Flash bulbs in suitable reflectors are very satisfactory in underwater photography. They may be held close to the surface of the water and synchronized to the shutter by a wire extension from the trigger release mechanism; or better still, they may be used in the hydroscope above or beside the camera. In such cases, the window must necessarily be large, or an accessory window must be provided for the flashbulb. Since the lens or lens-shade of the camera should always be kept as close to the glass of the window as possible, and the inside of every good hydroscope is painted a dull black, reflections are kept to a minimum. However, when using flashbulbs inside of the hydroscope, every effort should be made to prevent light from the bulb from striking the glass of the window close to the camera lens, or annoying streaks will appear in the negative.

Color films will produce marvelous underwater pictures, especially in moving pictures, and there is often ample light for its proper exposure. Colored pictures produce much more definition than black-and-white and should be attempted if it is at all possible. The addition of color to your black-and-white underwater photographs will always improve them and can easily be secured by toning the prints green or by placing a green filter in front of the projector lens when showing moving pictures. Blue toning also adds a realistic touch, especially if the audience has become accustomed to thinking of all water as being blue in color, as is often their belief.

For those adventurous souls who are at home on the ocean floor in amateur or professional diving equipment, the construction of a waterproof metal camera housing will permit them to carry their camera with them on every descent. Such equipment permits the recording in color of intimate details of ocean life that are often of tremendous value to science and are vastly superior to anything obtained through the windows of partially submerged concrete observation posts, such as have been used in the study of undersea life in the past. Furthermore, with this equipment, a careful photographer can produce underwater moving pictures that rival Hollywood's. If a person is handy with tools or can enlist the aid of a sympathetic friend, he can construct a waterproof camera housing at very little expense. The first underwater camera housing we ever built is still in active use and gives as good results as any custom-built affair, although it consists of a light gear housing

rescued from a scrap pile and some old plumbing fixtures from the same source.

Fortunately, the salvaged gear housing accommodates a 16 mm. cine camera perfectly, and no changes were necessary in its interior other than the addition of a metal platform to which the camera is fastened by a knurled bolt threaded into the tripod fitting on the bottom of the camera. The lens faces a small plate glass window held in the end of a short section of pipe which is welded into the front of the housing and threaded on the end to take a standard pipe cap. A window is cut in the end of the cap, and the plate glass is ground down around the edges to fit snugly inside of the threaded portion. Thus, when the cap is tightened on the end of the pipe, it forces the window tightly against rubber gaskets and forms a watertight joint between glass and pipe. Any unnecessary openings in the housing are covered with metal, welded into place. A rubber gasket fits between the housing and its cover, and the stud bolts which hold it in place are fitted with wing nuts which can be tightened easily by hand.

By means of a crank which engages the winding shaft on the camera, it is possible to wind the camera through the cover of the housing without bringing it to the surface. The crank passes through a packing box made from part of an old water faucet. It is surprising what splendid waterproof fittings these discarded plumbing fixtures make, especially when they are carefully packed with graphited packing such as is used in automobile water pumps. Through a similar packing box passes a lever for depressing the starting button on the camera. The whole affair is mounted on a sturdy tripod made of water pipe.

Probably the most useful fitting on the camera housing is a small tire valve removed from an inner tube and threaded into the bottom of the housing in a protected spot. After the camera has been placed in the housing and the cover tightened in place, a tire pump is attached to this valve, and air is forced in under a pressure at least as great as the water pressure at the depth to which the apparatus is to be carried. This air proves very helpful. As soon as the camera is lowered into the water, the presence of bubbles will betray unsuspected leaks which would otherwise permit water to enter and damage the equipment. As the housing is lowered still more, the increasing water pressure is unable to crush or warp it; and should a sudden jar or strain cause a leak to develop, the sudden escape of air will serve as a warning and permit the apparatus to be raised to the surface.

Before using an underwater camera of this type, it is well to take an exposure meter reading. In shallow water, a satisfactory reading can

be obtained from the surface by using the hydroscope and an exposure meter in the manner already described. For really careful work, however, it is preferable to carry the meter directly to the scene. This can be done especially well with a Weston meter. The center is first cut out of a piece of plastic material or bakelite, and the meter fitted into the frame thus formed. Rubber gaskets are cemented to the frame, and the whole affair is sandwiched between two pieces of plate glass held in place by a light metal frame. The diver uses this meter just as though he were on dry land, aiming it at the area to be photographed and reading the light intensity direct from the instrument.

When the diver receives the camera from the surface, he fastens it securely to the tripod, which has already been placed in position, and aims the camera at the area which interests him. Upon depressing the lever which starts the camera motor, he not only takes a picture but is also free to walk around in front of the lens and enter the scene himself. Underwater pictures profit greatly by the addition of a human figure to lend a sense of reality to unfamiliar scenes and to provide a convenient object for use in judging size and distance.

As in any other field of photography, the success of underwater work will depend to a large extent upon the ability and resourcefulness of the individual photographer. Thus it is that some readers must already have thought of innumerable improvements and adaptations for the apparatus described here, while others have undoubtedly abandoned all hope of ever taking an underwater picture, merely because their camera isn't equipped with an f:1.5 lens! To the former is extended a hearty invitation to lend their talents to the small but rapidly growing group of photographers who are exploring and recording the beauties that lie beneath the sea; while to the latter is offered the comforting thought that, no matter how poor their equipment may seem to be, it can scarcely ever be as bad as Dr. del Valle's famous "$2000 underwater camera!"

HYGEIA, the Health Magazine published by the American Medical Association, 535 North Dearborn Street, Chicago, Illinois, is offering $500 in prizes to the amateur and professional photographers who can best capture the essence of health in a photograph. The official registration blank appears on page 158 of the February 1940 HYGEIA. Entries must be made before April 1, 1940.

PHOTOGRAPHY OF THE PNEUMO-MUSCULAR SYSTEM OF INSECTS

LEO C. MASSOPUST*

IN a recent article, Carey[1] presents experiments on the pneumo-muscular system of aerial insects. He demonstrates that there is an anastomotic network of minute air channels ramifying throughout the interior of the muscular protoplasm, which is directly continuous with the tracheoles and trachea found between the muscle fibers. Photomicrographs of this complex respiratory system of delicate canaliculi are shown, which were obtained from the leg and wing muscles of the silk moth, domestic fly, cockroach, grasshopper, dragon fly and the honeybee.

When the insect is killed by highly volatile alcohol, ether or chloroform, the gas formed within the lumen of the tubules is replaced more rapidly than when the tubules are filled with ordinary air. Hence it is advisable to behead the insect when preparing frozen sections of the muscle fibers.

* Received for publication November 2, 1938. Department of Anatomy, Marquette University School of Medicine, Milwaukee, Wisconsin.

[1] Carey, E. J., Studies of the wave mechanics of protoplasmic motion. X. Experiments on the pneumo-muscular system of aerial insects. The biophysical basis of compression and decompression during internal respiration of the hitherto unknown functional intracellular aerial canalicular apparatus within the interior of each cross-striated muscular fiber of air-breathing insects. *Am. J. Anat.*, 61:159-201, July '37.

EXPLANATION OF FIGURES

Figure 1. Photomicrograph of longitudinal and surface views of whole, unstained, cross-striated muscle fiber of the wing of the young moth (Samia cecropia). The teased muscle fibers were fixed for one hour in formalin, mounted in glycerine and photographed immediately. The trachea and intercellular tracheoles are filled with residual air, thus appearing black, and having double contours.

Figure 2. Photomicrograph of the same microscopic section and field made twenty-four hours later. It is to be noted that the glycerine has replaced the air in nearly all of the tracheoles and pars of the larger tracheation.

Figure 3. Photomicrograph of the same microscopic section and field after forty-eight hours. The glycerine has replaced almost the entire mass of trachea and tracheoles.

Carbon arc illumination, Wratten B filter, D.C. Ortho Plate with an exposure time of 3 seconds was used in figures 1, 2 and 3.

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It is to be noted, that, since the true tracheation of aerial insectan muscle fibers contain air, it is imperative that freshly teased living muscle fibers, as well as frozen microscopic sections be studied immediately. If either of these preparations are allowed to remain in a liquid for any length of time, the air is replaced by the liquid causing the tracheations to become invisible. In many instances it is possible to observe the air escaping from the air tubules in the form of bubbles. The frozen sections are mounted on the microscopic slide in a ten per cent solution of glycerine. Immediately a gradual displacement of the air within the pneumo-muscular system can be observed. Apparently the glycerine has the same refractive index as the coagulated fluid in the muscle.

It is therefore obvious that photomicrographs of this type of muscle tissue must be made as quickly as possible after mounting, for the entire tracheal system may be replaced by the glycerine within five or six hours. The photomicrographs, figures 1, 2 and 3, demonstrate this gradual replacement over a period of forty-eight hours.

BOOK REVIEWS

THE YEAR'S PHOTOGARPHY 1939-1940. 18 *text pages,* 64 *reproductions of pictures from the Society's* 84*th annual exhibition,* 7¼ *by* 9½, *paper covers, price* $1.25. *London, Royal Photographic Society.* (*American Agents, American Photographic Publishing Co.*)

The work of outstanding photographers from all parts of the world is presented in this annual publication. It includes a number of beautifully printed photographs—pictorial, natural history, record—that were exhibited at the 1939 R.P.S. exhibition last September and October. There is also an article "The Pictorial Side of Photography" by J. Dudley Johnston, Hon. F.R.P.S., discussions on "The Lantern Slides" by R. H. Lawton, Hon. F.R.P.S., and "The Naturalist and the Camera," by E. W. H. Selwyn.

FOTOGRAFIA DEL ESTOMAGO. *Jose P. Uslenghi, Herbert Hofmann, Joseph Heilpern. Anicet Jopez—imp.—Buenos Aires,* 1939. 215 *pages,* 275 *illustrations.*

This volume published in Spanish, contains an exhaustive survey of the subject of gastrophotography. Many methods are discussed in a chapter on the historical consideration of the subject. Equipment and general technic are well presented. Manipulation and preparation of the patient, contra-indications and a series of clinical observations make up part 1. Part 2 deals entirely with interpretation of the gastrofotogram, profusely illustrated. An extensive bibliography is included.

THE EDITING OF SURGICAL MOTION PICTURE FILMS*

LEONARD A. JULIN†

THE term "editing" refers to any changes, additions or eliminations made in a film after it has been processed. No matter how carefully the film is planned and photographed, it can be improved by proper editing. A scenario may have been used as a guide in determining what action should be filmed but the length of the scenes is best determined during editing. Both photography and editing will be influenced by the purpose for which the film is to be used. The American College of Surgeons[1] lists films for distribution for (1) the medical profession in general, (2) specialists only, (3) medical students, (4) hospitals, and (5) the lay public.

The majority of surgical films will be found in the group prepared for specialists but such films generally are edited to interest the profession in general. It is this group of films that in this paper will be considered as typical. Films for medical students should contain more elementary details of surgical technic and such films will naturally require more footage. Films used by hospitals fall into two groups, those used for instructing student nurses and those used for purposes of publicity. Films for the lay public will show the results of surgery rather than surgical technic. It is obvious that, to serve best the purpose of any one classification, the scenes and titles should be especially planned for that group.

The typical surgical film may show the position of the patient on the operating table, the site of the incision and the main steps of the operation. To this may be added preoperative and postoperative photographs, roentgenograms and gross and microscopic specimens. Often, the addition of drawings or diagrams improve the portrayal of the subject. Illustrations already available are seldom as satisfactory as those especially prepared for motion picture reproduction. Such drawings should be simple in design and the lines and lettering bold enough to be easily seen by the entire audience when the film is projected. The use of animated drawings is effective but involves much time and labor in production. As an alternative method, a number of surgical films have

* Read before the ninth annual meeting of the Biological Photographic Association, Pittsburgh, Pennsylvania, September 14 to 16, 1939.

† Photographic Department, The Mayo Clinic, Rochester, Minnesota.

[1] Medical motion pictures which are approved by the college. Bull. Am. Coll. Surgeons. 21:299-308 (Oct.) 1936.

been improved by demonstrating part of the technic on models made of soft plastic materials. After the pictorial part of the film is completed it is ready for the addition of titles.

Titles

The purpose for which the film is to be used will determine the phrasing and number of titles employed. If dealing with the typical surgical film to be shown before specialists and the profession in general, the terminology familiar to such an audience should be used. The main title should be so worded that it will not be misleading as to the nature of the film when it is listed on programs or is indexed in film directories. Following the main title will come the subtitle bearing the name of the surgeon and institution or city. This is usually followed by a short subtitle, the name of the photographer. Next, an introduction to the subject is presented and usually consists of the patient's preoperative history. This should be presented in past tense as concisely as possible; it should be remembered that the use of many dates is confusing. Dates often can be replaced by such terms as, "of seven weeks' duration," and thus eliminate the need of mental calculations by the audience. Preoperative pictures and roentgenograms are presented in this introductory part of the film.

Beginning with the surgical portion of the film the titles are worded in the present tense. Short titles inserted before each step of the procedure are better than one long title at the beginning of the operation. Titles are used where necessary to explain the scenes which follow. They also may be used as substitutes for certain scenes if one wishes to shorten the projection time. A title mentioning postoperative care may follow the surgical portion of the film. Postoperative pictures of the patient and specimens should be preceded by titles worded in the past tense. The use of present tense for only the surgical portion of the film helps to create the illusion that one is actually present at the operation.

Several short titles are more satisfactory than one long scroll that contains the same textual material. If a scroll is damaged, it is usually necessary to replace it with a new one because a splice is much more disturbing in such a position than it would be on a stationary title. Approximately two and a half to three lines of typing on manuscript paper may be used for a single stationary title. A typewritten copy of the titles is used as a guide when the titles are to be spliced into the film. Detailed information such as the name of the patient and exact dates

may be recorded on this sheet for reference because such details are not used in the film. There are many ways in which titles can be filmed but for surgical subjects, plain titles are more appropriate than those that contain spectacular animation or color effects.

MECHANICS OF EDITING

As most surgical films are now made on 16 mm. reversal film without recorded sound, only this type will be considered in this paper. The first step in editing is to assemble the film on one reel and project it to note its general appearance. Any unsatisfactory sections, such as where the field is obscured by the surgeon's head or hands, are marked for cutting. For this purpose, a projector having forward and reverse movement is most convenient. A bulb of low wattage is satisfactory for this purpose and is less likely to overheat the film. One of the new editing units which fits on the rewinding board and is equipped with an intermittent mechanism can be used but a projector is more useful in "timing" the film. The projector is stopped, with its light off, and the film is marked with a light red grease pencil. A transverse line is placed at each point where the film is to be cut and the letter "O" is marked at each end of the strip which is to be removed. An excessive amount of the crayon should not be used as it may accumulate on the projector film channel. Each title on the typewritten working sheet is given a number and this number is then marked on the film where the title is to be inserted. With the film marked in this manner the splicing can be done at a later time by anyone familiar with the system.

SPLICING

Poorly made splices detract greatly from the screen effect of the film, whereas splices correctly made are unnoticed. In making a splice, only the emulsion under the overlapping end of the film should be removed. If emulsion beyond this point is removed it will result in a white flash on the screen. If a carefully made splice appears too conspicuous on the screen, it may often be improved by changing the overlap of the adjoining ends. The cement is applied discreetly and pressure is applied promptly to the splice for about twenty seconds. The film is then taken from the splicer and excess cement is removed by wiping parallel with the cut ends of the film. The film should be handled with care until the splice is dry. Water should be used only

sparingly when removing the emulsion from Kodachrome film or the splice may show a band of bright color. Abrupt changes at splices can be softened by local application of dye to produce a fade-out and fade-in (Fotofade)[2].

Timing

The term "timing" refers not only to the projection time of the whole film but also to the action in each scene. Some of the scenes may seem to "drag" and can be improved by cutting without eliminating important action. Some of the titles may remain on the screen too long and should be shortened if necessary. Usually scroll titles need cutting both preceding and following the moving portion of the scroll. As projectors vary in speed and some persons read more rapidly than others there is no definite rule for determining the length of time that a title should remain on the screen. A satisfactory guide is to have it remain long enough to read aloud one and one half times at average conversational speed. This is sufficient time for the slow reader and yet the film does not seem to "drag" for faster readers. Some titles, such as those which state the drug and dosage used for local anesthesia, can remain longer to give the readers ample time to note them carefully. A fundamental rule of motion picture production is that the movies must move and this is the rule to follow when "timing" the films. A film carefully edited will present the subject clearly and concisely and will leave the audience with a desire to see more of such films.

[2]Dye Research Laboratories Los Angeles, California.

1940 PHOTOGRAPHIC TRADE SHOW AND CONVENTIONS

This coming August, from the 19th to the 23rd, inclusive, there will take place at the Stevens Hotel, Chicago, Ill., a photographic event of the first magnitude. During those five days The Photographers' Association of America and The National Photographic Dealers' Association will hold their annual conventions and the two organizations will join in sponsoring a Trade Show which will put all past shows, convention exhibits or similar affairs thoroughly in the shade.

APPLICATION OF CLINICAL PHOTOGRAPHY TO PRIVATE PRACTICE

F. R. HARDING*

THERE are many ways in which photography can be useful in private practice, particularly, in illustrating the clinical record, in reproducing copies of charts, and in the reproduction of gross surgical specimens.

The average inexpensive folding camera is not suitable for clinical work because it cannot be used for close-up views, and cannot be accurately focused. A camera of the type described below has the advantage of being adapted to ordinary snapshot work out of doors as well as being very useful for clinical photography, and, is thus capable of serving in a double capacity.

There have been a number of cameras on the market which contain most of the features necessary for successful clinical photography. Three that come to mind are the Zeiss "Trona," the Voightlander "Avus," and the Eastman "Recomar." These cameras come in two sizes, 2¼" x 3¼", and 3¼", x 4¼". The last named size, 3¼" x 4¼" is to be preferred as the picture is large enough for record purposes without further enlarging. These cameras together with all needed equipment are relatively inexpensive and can be bought in any large city. A light folding tripod is needed and a separate tilting head which fastens to the tripod head will be of great assistance on many occasions. This type of camera is similar in appearance to the ordinary folding pocket camera, but it has a double extension bellows which permits taking photographs life size, or larger. This is an ideal feature for reproducing skin lesions. In addition to the usual engraved scale on the camera bed, which is useless in clinical work, there is a ground glass focusing back with a folding hood, rendering a focusing cloth unnecessary and at the same time, protecting the glass when closed. The cameras are fitted for the use of plates and film pack; the latter being preferable since it is much easier to handle and requires no dark room for loading. A film pack adapter should be included when the camera is purchased.

There are numerous lamp stands on the market which take Photo Flood bulbs. Nearly all of these are satisfactory for clinical purposes. The use of artificial light is stressed because it is a constant light source while daylight is not. Photographs should be made with all the shades down. Once the proper exposure is found, it will not vary unless the light is moved away from the patient which obviously necessitates an

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increase in exposure time. Four of the Photo Flood bulbs may be safely used on one circuit.

A plain background is needed for clinical photography for which a dark wall, or a dark blanket pinned to the wall will serve very well. To make a picture, the tripod must be assembled and the camera fastened to it with a tripod screw. The lamp is then placed in position and plugged into the nearest electrical outlet, while the camera is arranged in front of the patient with the lamp close beside it. The closer the lamp is to the camera, the less shadow will be found on the background. The undesirable shadows may also be kept down by placing the patient close to the background. The hood, or cover over the ground glass focusing screen at the back of the camera, is now unfastened and the diaphragm of the lens opened as wide as possible. The shutter indicator is put on time and the shutter opened by pressing the cable release. The image is then sharply focused on the ground glass by racking back and forth on the focusing screw at the front of the camera. One must, in focusing, be careful to look *at* the ground glass and not through it. As soon as the image is focused, the lens is again closed by pressing the cable release. The shutter indicator should be set at one-half second and the diaphragm of the lens closed to f:8. The film pack adapter is then inserted and the unused film pack is placed inside. The dark slide which is found in front of the adapter is pulled out. The film pack safety tap which is found in front of the number one tab in the pack must be pulled up as far as possible and torn off. With the patient absolutely still, the cable release is pressed and the exposure made. The dark slide in the adapter is then reinserted and the number one pack tab is pulled straight up as far as possible and torn off. One is then ready to focus the next picture.

The above mentioned exposure, one-half second, is only approximate, but a few trials at different exposures will give the correct exposure time. The diaphragm opening given as f:8 has been found to be the largest opening of the lens that will give sufficient depth of focus. The meaning of this can be best demonstrated by focusing the camera on an oblique angle to a wall with the lens opened to its largest aperture, usually f:3.5 or f:4.5. Focus on an object on the wall about eight feet from the camera. Only a small area of the wall will be sharply focused. If the diaphragm is now slowly closed more of the wall appears sharply on the ground glass. The larger the diaphragm opening, the shorter, of course, will be the exposure. In general, the diaphragm openings of about f:8 will be found satisfactory. The exposure will not be too long and with an adult patient no movement should be apparent.

Any company developing and printing amateur films will develop

the film pack. It is not necessary to wait until the 12 exposures are made, as exposed films can be taken out without damage to the unexposed ones. In order to do this it is necessary to send the pack adapter to the company, at the same time pointing out that the pack is not all exposed.

The finished print can be fastened to the patient's record, thus affording a permanent illustration of the patient's appearance on that date. The negatives should be put in an envelope containing the patient's name, diagnosis, and date of the photograph and then filed.

A short article by Dr. Oscar Richards, Spencer Lens Company was reprinted in the Gradwohl Laboratory Digest, December, 1939. As it contains a good suggestion for our members, particularly our lecturing members, it may be well to re-reprint it here:

> The effectiveness of a lecture is sometimes marred by the lantern slides appearing on the screen in a different order than planned by the lecturer. The incorrect order may arise from an accident as the slides are arranged for projection by the operator, or they may not have been in proper sequence when given to the operator. A common source of scrambled slides comes from placing the slides in the boxes in which the plates came, numbering the covers for the boxes and then placing the wrong covers on the right boxes. When the operator puts them in one pile according to the box numbers, it is very difficult to correct the order without a prolonged intermission during the lecture.
>
> These difficulties may be prevented by numbering each slide with a red china marking pencil. The number is written on the glass over the mask and will not show on the screen. Any misplaced slide is noticed by the operator of the lantern and placed in its proper place before it is projected. When a slide is to be used again later, it will have two or more numbers and the operator will place it in the proper sequence for its next showing when he removes it from the lantern. After the lecture the numbers may be rubbed from the slide with a dry cloth.

CHATS WITH THE EDITOR

SOME PICTURES ARE WORTH TEN THOUSAND WORDS, BUT—!

THE catch is, of course, that sometimes the ten thousand words aren't fit to print in the proceedings of a scientific society.

My experience with applying in publication the fruits of scientific photography, or better, the photographing of biological subject matter, extends over so long a period that I don't like to think about it. In its chosen field of genetics and related subjects, the Journal of Heredity publishes rather more half-tone reproductions of photographs than most of the other publications in this field combined. Thus the things I have learned, and the trials and tribulations I have suffered, are based on a fairly good cross-section of the technique of photography as it is used, misused, and abused in this field. Time does not permit a detailed review of the photographic plusses and minuses I have encountered, so I shall confine myself to the misuses mostly. The things I am going to scold about are not isolated examples of queer photographic behavior or misplaced or misapplied photographic judgment. They are, each of the horrible examples I shall cite, type specimens of photographic misbehavior I have constantly been exposed to during the past twenty years. If some of my examples seem silly and trivial, that is not actually so, for they constitute a continuing source of expense, irritation, and wasted effort in correcting things that should not have happened in the first place, and which when corrected so far as that is possible, leave only a passable final result.

Before going into the details of my indictment, it might be worthwhile to touch briefly on the philosophy of scientific photography. (Do I mean scientific photography or photographic science or photography of science? It is like photomicrograph and microphotograph, one never is quite sure which word to use,—and generally the other one turns out to be correct!). Some years ago the statement was made that the ultimate end of research is publication. Research which ends up only in notebooks, and even that which flowers into doctrinal theses on the shelves of a few libraries, is not fully incorporated into the corpus of human knowledge and fails of its ultimate social purpose. In the same way, science photog-

raphy should have as its ultimate aim, publication. Much of it will never see the light of the printed page. Many of these unpublished photographs will be important nonetheless as a convenient, and if properly done, a permanent record. Going over my file of photographs I am tempted to emphasize that point. So many prints and negatives fail of permanence because the simple ABC's of photography are not adhered to.

Publication involves more than merely the photographic part of the technic. An integral part of it is bound up in the making of half-tones from the photographs and in the printing of the half-tones. In this process much or little detail may be lost. It is a waste of time to expend very much energy in our photographic department if the printing presses aren't going to do right by us.

The photographer needs to keep the possibility of publication in mind, to realize that under the very best conditions there is some loss of detail in any of the processes of reproduction for printing, and to assure that in his part of the processes the definition and emphasis, the tones of light and shadow, are adequate so that the final result is not meaningless when a bit of detail is lost. Not infrequently, I have to ask an author: "Are these the best photographs you have? Can't you give me something with a little more detail?" And not infrequently the author's reply contains a note of irritation: "These pictures are good enough and show what I want to show." Good enough for the specialist dealing every day with the organism in question perhaps. Not good enough as a record and not even clear to the researcher's colleagues dealing with other related organisms. Christopher Morley once said that the problem of the writer is not to write so he can be understood but to write so he cannot possibly be misunderstood. The problem of the scientific photographer is the same. He must make the record clear enough so that it can be understood not only by the research specialist but by other workers at a later date and after it has been reduced to a half-tone and printed.

All too frequently in the field of biological research this requirement is not understood or is ignored. The photographic records are made so poorly that they may easily be misunderstood. They lack so much in detail that they convey little or nothing to the reader or to a worker in the same field who has not dealt with the materials directly. The photographs are not records: they are simply scribblings in a field notebook, adequate to jog the memory of the worker but hardly legible to another person. Very frequently I receive, with articles, such notebook jottings by the photographic route. Sometimes the difficulty is that adequate equipment is not available and that a job requiring the

best skill of the photographic artist, with adequate lenses and a solidly built camera, is done by the snap shot route as though we were on a picnic at the seashore.

Probably this is controversial ground in a gathering of photographers. But from my point of view, the size of photographs submitted to me for publication is usually too small. The miniature camera is a marvel of compactness and efficiency. A skilled and sympathetic operator who knows the peculiarities and limitations of his instrument, can get astonishing results with a camera taking a photograph even as small as the Leica. From the point of view of making publishable scientific records, the Leica-sized camera is mostly a delusion and a snare. To make a half-tone breaks any photograph up into a series of varied sized black dots. When a Leica print is blown up to five by seven, every point in the original is of necessity a disc, howbeit a small disc, in the enlargement. So when these discs are further broken up by a half-tone screen there is inevitably further loss of detail. If the original is excellent enough, this loss may not be serious. Frequently the result is outstanding in the field of subjective photography. It has oomph; it has atmosphere; it has charm. But it does not have detail. I would guess that the proportion of Leica prints which would make acceptable five by seven half-tones would run a fraction of one per cent. I am speaking now of scientific records, not of news photography or of art photography of the modern school. Some striking results are obtained often by blowing up very small negatives to the size of a large page. I submit, however, that these have ceased to be records of detail of form. They may be striking photographs, but they are subjective photographs rather than objective photographs. From my experience, a publishable scientific record should not be much less than five by seven in an ideal world. Most of mine aren't that big. Often when the entire print is, the germane portion covers only a fraction of the area, so my working size stays reduced.

All that might be changed if our biological research institutions were adequately equipped with photographic staffs to handle the job of research photography as a specialized profession. Certainly if the quality of photographs is going to be far from perfect, I should much rather start work on a mediocre eight by ten contact print than on an eight by ten enlargement of a mediocre Leica negative. I am afraid that we will be dealing with considerable mediocre photography in this field for a good while to come.

We will pass over the mechanics of photography with the perhaps hopeful belief that that will take care of itself and work out for the

best. Among my major troubles are several formidable ones in the field, not of focusing the camera or of giving the right exposure, (important as these are), but in the arrangement of the subject. Our scientific photograph is a form abstract of a phenomenon of some kind. The part of this abstract which does any good is what gets through the human eye to the human brain. For that reason the surroundings of our abstracts are important. One important element of a photograph is a size scale. What metrical relation is there between our photographic print and the original object? That is sometimes taken care of by natural size photography or by enlarged photography of small objects, stating the number of times an object has been increased in size. To most people this is a thoroughly meaningless procedure, but so is talking in millions and billions, so it is probably as good as we can do. When our object covers more area than there is on the photographic plate necessarily the photograph must be reduced too. There are various ways to show scale in a photograph. One technique is to include in the picture an object of recognized size to give the photograph scale. A human hand sometimes serves for this, or a jackknife, a watch or hat. Hands, jackknives, watches and hats have a certain standardization of size within a reasonable limit. Even more exact as a way of furnishing a scale is to put a ruler of some kind in the photograph. This solution occurs to a great many photographers of scientific subjects. It always amazes me how casually the inclusion of a metrical scale is treated. One of the biological supply houses has a celluloid ruler which carries Agassiz's aphorism "Study nature not books." This bit of wisdom has stared at me from dozens of scientific photographs,—and generally with its attention-value heightened by being placed at a rakish angle. I don't know why scales in a scientific photograph are practically never put into the composition at right angles to, or parallel to anything. All too often they are stuck glaringly into the middle of the photograph without any regard to its composition. What we are trying to concentrate our thoughts on in a scientific record is a phenomenon. Sometimes this phenomenon seems to take second place to the scale, which is only a coordinate of reference.

And much the same kind of thing goes for the background of our photographs. There are various schools of thought with regard to backgrounds. One goes in for variety. It does not make so much difference what is in the background to furnish this motif: old mowing machines, a hodge podge of wire fence, a row of fence pickets is also popular. Then there are the quick starters—who get part of a background but don't finish. They say "Let's have a background" and dash out something that is excellent as far as it goes. Unfortunately it doesn't go

anywhere near the edge of the area of interest, leaving part of the photograph with a contrasting or neutral background and part of it without this adjunct. The result is far from successful. Then there is the group which seems actually to go to considerable lengths to figure out ingenious camouflage in the selection of the background for our drama of recording and interpretation. This school of thought sometimes shows an almost devilish ingenuity in the choice of materials. One experience which still rankles had to do with the study of spotting in the humble porker. These creatures had a black body color and white spots or vice versa. The records were made by standing them up against a brick wall laid in Flemish bond, with bricks of three colors. The result was an excellent study for the camouflage department of the Army but left something to be desired as a record. Where did the pig begin and the bricks end? That was really a problem. When I carefully cut out the pigs and pasted them on a white background using a hand lens to decide where porker ended and masonry began, the author let out a fiendish howl that I had forever ruined his records by "retouching them." The final result gave a fairly clear idea of what kind of spots the pigs had. The question at issue was: "Was this what we were after; or were we interested in protective coloration?" A recent crisis has followed somewhat similar lines. Here an earnest and well equipped seeker after knowledge regarding the genetics of turkeys recorded his results regarding the barring of the flight feathers of the wing by photographing the turkeys against a white screen with about a half-inch mesh. The result was a merry game of hide-and-seek to decide where the barring of the screen began and that of the turkeys ended. Is the editor to be blamed because, knowing what the final result is going to be when printer's ink meets paper, he protests, and if he is worth his salt does something about his protest? Such work if carefully and conscientiously done takes an enormous amount of time, and the result is admittedly not nearly as good as a properly staged and properly made photograph in the first place.

I suspect that the field of experimental biology lags photographically behind other biological fields such as that of medicine. My personal experience leads me to this conclusion. The hospitals, for instance, seem to be taking their photographic record-making much more seriously than the research laboratories. This is too bad, because carefully done photography is a most valuable adjunct to research. And if the aphorism that publication is the ultimate aim of research is correct, we may count

as only partially successful a research which leaves no adequate photographic record of the material with which it dealt.

Of course one could say a great deal about the importance of adequate photography as an educational force in advancing the scientific method. I have very strong feelings on that myself in connection with the publication of the Journal of Heredity. We know that the photographs we have published have been of tremendous value in interpreting biological science to students and to the general public. Hundreds of them have been used in text books, and other publications, as lantern slides and in other ways. This job would have been done better had our photographs averaged of higher quality. We have had to spend much time and money to correct as well as we could basic faults in photographs which, not made right when the material was available have been forever lost to correct rephotographing. I am convinced that the job of the research worker in advancing human knowledge, and in doing his rightful share in making his discoveries a part of the fund of knowledge of our race, is tremendously helped by really skillful and imaginative photography. I am reminded of a dominie who was caught on the stand for cross questioning in an ecclesiastical evolution trial. The advocate for the defense asked him to reiterate his stand with regard to the flatness of the earth and other matters. The witness "stood on the word" and was proud of it.

"What you are really proud of is your ignorance, is it not?" insisted the remorseless questioner.

"Well, if you want to put it that way, yes," snapped the witness, huffily.

Some of these things I have been scolding about are ignorance, indifference, and lack of imagination. To defend them as "good enough" is really a smug pride in ignorance and slovenly thinking. Some day let us hope, the pictures made in the field I have covered will all be worth ten thousand words—and not cuss words either. Slovenliness in this respect is no more a virtue than it is in any other form of human expression.

ROBERT COOK,
Editor, *Journal of Heredity*,
Washington, D. C.

CURRENT PHOTOGRAPHIC ABSTRACTS

2915-09

A Submarine Photometer for Studying the Distribution of Daylight in the Sea. C. L. Utterback and P. M. Higgs. *J. Opt. Soc. Amer.*, **28**:100-02, April, 1938. The construction of a photometer which is designed to measure the intensities of narrow spectral bands of submarine daylight is discussed. The photometer is capable of making rapid and nearly simultaneous measurements of spectral bands of both transmitted and scattered light. The design permits operation from a boat which is not provided with special electrical equipment. (Author's Abstract.)

31-054

Adapt Your Movie Camera for Speed Stills. S. A. Pearl. *Pop. Photography*, **2**:35, 87-8, March, 1938. Examples are shown and working details are given of the results obtained with a motion picture camera which has been equipped with a shutter having smaller sectors than normal. Still pictures may be made in 1/640th second. G. E. M.

F1-019-3207

Helpful Charts and Their Uses. R. F. Mitchell. *Amer. Annual of Photography*, **52**:230-34, 1938. The five graphical solutions to photographic problems presented are used to determine: (1) the magnification and focal length of lens combinations; (2) the extension employed for given object distances in photomacroscopy, with 16-mm. to 6-inch lenses; (3) the angle of view included by lenses of from ½-inch to 20-inch focal lengths for the width, length, or diameter of a large range of formats (8 mm. to 8 inches by 10 inches); (4) the economy of the voltage employed with projection lamps in terms of cost per hour, life, and screen illumination; and (5) the screen brightness from its dimensions and the lumen rating of the projection lamps. R. W. H.

K2321-K231-K/4

The Basis of Color Stills. C. Hoffman. *Intern. Photograper*, **10**:10-13, May, 1938. High-intensity arc lights and photoflash lamps have been found to be satisfactory for making color-separation negatives at small apertures and high shutter speeds. Both of these light sources require slight filter compensation. E. W. J.

A Review of the Mechanical Improvements in Microscopes in the Last Fourteen Years. R. S. Clay. *J. Roy Microscop. Soc.*, **58**:1-29, March, 1938.

PHOTOGRAPHY IN THE STUDY OF THE EYE*

CHARLES F. KUTSCHER, M.D.†

IN PHOTOGRAPHING the structures adjacent to the posterior wall of the eyeball, the eyeball itself forms part of the optical system of the camera. Since the eyeball is a very poor optical instrument in that all types of aberations are present, certain defects will occur in the negatives but after a little experience in viewing retinal photographs these defects are promptly discounted.

The camera was devised by Dr. Nordenson and is composed of a Gullstrand Opthalmoscope combined with a reflex camera and compur shutter. The camera is made by the Carl Zeiss Company. The source of illumination is the carbon arc operated by direct current at 4 a series of prisms and condensing lens, and leaves the camera through the opthalmoscope lens. An image of the luminous slit of the crater is to 6 amperes, 125 volts. The light emitted by the crater passes through formed on the cornea just within the rim of the pupil. The rays pass through the eyeball and are reflected by the retina and choroid. The reflected rays pass through the center of the cornea. The inverted image passing back through the opthalmoscope strikes a mirror which reflects an upright picture into a finder which is on the same plane as the photographic plate. The greater portion of heat from the light source is removed by a ferric oxide glass. A gray filter is interposed in the system which cuts down the brilliancy of illumination so that the examination and focusing may be done without discomfort to the patient. When the cable release is depressed this gray glass and the mirror are automatically displaced.

The camera is placed on a compound slide so that the instrument is easily moved from right to left, and forward and backward. Vertical adjustments are made by a screw on the upright.

The patient is seated comfortably at the instrument and advised about the brilliant light that suddenly flashes in his eye for an instant and cautioned not to move the eye once it is in the proper position. The head is then fixed in an adjustable head and chin rest.

When patients have binocular vision, proper positioning of the eye to be photographed is simple. An assistant holds a very small pencil light in her hand and the patient is asked to look at it with the eye not being photographed. The operator, viewing the lesion through the camera, moves the assistant's hand about until the lesion is brought into

* Presented at the convention of the Biological Photographic Association, Pittsburgh, Pa., September 15, 1939.

† Medical Arts Building, Pittsburgh Pa.

the proper position. Then the crater slit image on the cornea is again checked and if the position is correct, the exposure is made.

The camera is equipped with plate or film holders. The plates are 4.5 x 6 cm in size and in our practice, Hyper Press Orthochromatic plates are used. With these plates, exposures vary from 1/5 to 1/10 second. We were never able to get sharp negatives with Panchromatic Plates. Our practice for the past year or so has been to use Kodachrome exclusively. As the spectrum emitted by the carbon arc is similar to daylight, Kodachrome for daylight is used.

The color of the fundus of the eye is made up of the white sclera, the choroid which contains considerable blood and melanin, and the retina which contains some blood. The components vary considerably even in different parts of the same eye, thus producing variations in the amount of reflected light.

It requires considerable practice to know the correct exposure to give, especially so since using Kodachrome. The intensity of illumination is controlled by varying the amperage from 4 to 6. The length of exposure is either 1/5 or 1/2 second. In a general way with light colored fundi the amperage is set at 5 or 6 and the exposure is set for 1/5 second. In a dark fundi, a 1/2 second at 4 or 5 amperes is used. In some fundi some dense black and pure white patches are present, then a compromise is often necessary.

Among the pre-requisites necessary for fundus photography is that the pupil should dilate well. The better the dilation the better the picture. The pupil is dilated by the use of homatropine and paradrene and after a wait of about one-half hour the patient is ready.

It is also necessary that the cornea, lens, and vitreous are clear in order to get a clear picture. If these structures are cloudy it has the same effect as trying to take a picture through a steamy window. It is possible to take a picture through media not too hazy but there will be a slight blur to the whole picture.

Often, light striking the retina in certain planes will cause certain areas to have very brilliant reflexes. These reflexes will appear in the photographs and will be somewhat confusing. They can be made to disappear by a slight movement of the eyeball.

A question frequently asked is, how much time does it require to take a fundus picture? With the average patient about five minutes is required. That includes focusing the carbons as well as focusing the image.

Information of considerable value can be gained by study of retinal photographs. Delicate changes in the retina adjacent to spasm of the ar-

terioles is usually brought out in rather sharp contrast. This change is frequently much better seen in a photograph than with the opthalmoscope. Changes in the reflection from arteriole walls are frequently much more contrasty in the photograph than in opthalmoscopic examination.

The sequence of events transpiring in a lesion over a period of months can be much more satisfactorily studied by a serial of photographs than by very exacting word pictures.

In photographing the external eye and adnexa, we use the Exakta Reflex Camera equipped with extension tubes A and B. With this combination the field covered is sufficient to include the whole of the lid in the picture. The iris diaphragm is closed down sufficiently to get good depth of focus, usually f:8 or f:11 is required.

The patient is seated at an adjustable table and the head placed in a head and chin rest where it will be kept rigid.

The source of illumination is a Bausch and Lomb operating light, the brilliancy of which is controlled by a resistance unit. For focusing, only feeble illumination is needed and just prior to the exposure the illumination is raised.

In photographing the external segment, Kodachrome A is used. The length of exposure can be studied with the Weston Meter. Exposures usually vary from 1/2 to 1 second.

Eyes suffering from disease of the external portions are frequently painful and sensitive to light. Because of this, the eye waters excessively and when a bright light shines upon the eye, the watering is excessive. Often the instillation of a local anaesthetic will render the eye less sensitive.

"MEN AND DUST," a two reel factual film dealing with the silicosis and tuberculosis stricken Tri-State lead-and-zinc mining area (at the juncture of Kansas, Missouri and Oklahoma) will be released in February by Garrison Films Inc. The movie will be available on 35mm. and 16mm. soundfilm.

"MEN AND DUST" is based on a study by the Tri-State Survey Committee Inc., 100 Fifth Avenue, New York City. Copies of the 100 page report may be obtained directly from the Committee.

PHOTOGRAPHIC TECHNIC

F. R. HARDING*

Lens Hoods

THE purpose of a lens hood, or shade, is to keep direct, but unused, light from striking the surface of the lens. When this is accomplished, there is usually an increase in the brilliancy of the negative. Much direct light reaches the lens surface when artificial light is employed because the light source is concentrated and is frequently placed ahead of, and at an angle to, the lens. Flood lighting is commonly used in clinical photography and the edge of these floods of light strike the lens surface. It is not uncommon to employ one or more lights directly facing the lens. Under these conditions it is imperative that a properly designed lens hood be employed if the best possible results are to be obtained. The lens hood should be kept in position at all times irrespective of the position of the lights.

There has been much talk about the employment of lens hoods, yet many photographers have never fully tested them to find out whether or not the advantages claimed were correct.

The lens hood may be made in several patterns some of which are not suitable for clinical photography. Adjustable hoods which are sold for use in portrait photography are sometimes designed in such a manner that only the top and sides are protected. This design is poor for clinical purposes because of the angles and low positions at which lights are employed in clinical photography. Another poor design from the clinical standpoint is the collapsible ring type. This is usually too short to effectively keep stray light from the lens surface.

A very serviceable lens hood may be made by the photographer. The hood which is made will be better than the one purchased because it will be made for one particular lens and focal length.

Procure a lens cap which is a snug fit over the front lens mount. Cut out the whole center or front of the cap, which will leave a ring. Make an experimental paper cone the small end of which fits over the ring. Place this assembly on the lens and view a scene on the groundglass focusing screen which focuses at the infinity point of the lens. Make certain that the lens is at the center of the picture area. Watch the four corners of the groundglass while raising and lowering the rising front board movement of the camera. Be sure that the corners of the image on the groundglass are not cut off at either the top or bottom during this movement. If none of the corners are cut off at the top or

* Received for publication February 6, 1940. Childrens Hospital, Boston, Mass.

bottom of the rising movement, reduce the diameter at the outer end of the experimental cone. Remember that the outer margin of the image cast by a lens is circular, and the camera is using only a rectangle imposed on the circle. When the rising front board is employed, the circle rides up or down on the rectangle formed by the groundglass. The outer end of the lens hood should be of a diameter great enough to allow no part of the image to be cut off on the groundglass, and yet have very little space between this point and the point at which the image begins to cut off. In other words the angle of view should be slightly greater than the angle of the lens hood.

When the proper diameter of the outer end of the lens hood is found, the experimental paper cone is employed as a pattern for a permanent lens hood. This may be cut from a thin sheet of black showcard stock which must possess a velvet-like surface having no sheen. If this is not procurable, thin cardboard or bristol board may be utilized by lining the inside of the cone with short napped black velvet held in place by glue. The edges of the cardboard cut from the paper pattern are brought together. Note that this is an edge to edge joint, not an overlap. The edges are held in position by black gummed paper tape. The outer surface of the ring is covered with glue and pressed into the small end of the hood. The completed hood is allowed to set until the glue is dry and is then ready for use. It is quite possible to work out the size of the lens hood mathematically, but the experimental method is quite rapid and equally satisfactory. The length of the hood should be not less than 3¼ inches.

The cone type hood does not allow the employment of a light filter unless it is of the cell type which screws into the front lens mount. If a filter of the square type is habitually employed, it must be placed on the rear element of the lens, or else a square type of lens hood must be made with provision for slipping the square filter into the base of the lens hood. In general, it would seem to be much more simple to place the color filter on the rear element of the lens.

TRADE NEWS

Mirotex Products Company of St. Louis, Missouri, manufactures a very efficient water filter. Two models are produced, the Senior and the Junior. These filter units are of the everlasting type in which the filter element is cleansed by reversing the flow of water through the unit. The filter unit is composed of a rigid structure of fine grain porosity through which the water will pass readily, but all suspended matter

contained in the water is retarded and collected on the face of the filter plate. When a diminishing of the water flow is observed, the flow of water is reversed either by bypassed piping, or reversing the filter itself and the collected matter is blown out and the filter plate cleaned.

E. Leitz, Inc. has announced a new projection screen especially adapted for colored motion pictures and color transparencies. The screen is washable, and the pictures projected on it can be viewed from almost any angle. The screen is known as the Leitz-Dmitri Projection Screen. Further information can be obtained by writing to E. Leitz, Inc., 7350 5th Avenue, New York, New York. This company has also produced the Universal Photo Optical Bench. The base of this equipment consists of two sturdy rods with supports at either end and the supports are provided with leveling screws. There are three stands which can be moved along the base and secured there when the correct position has been ascertained. One stand supports the camera, a second stand supports extension tubes, and the third stand supports a stage. The latter is provided with two lighting units and an upright ground glass screen for obtaining diffused back lighting. All parts of the bench can be locked securely and the final focusing made by moving the stage. This movement is made by remote control through the use of a flexible cable.

A new camera called "The Cameron Color-Flash Clinical Camera" is being introduced by the Cameron Surgical Specialty Company of Chicago. This camera employs both color and black and white film making a picture 1¼ x 1⅝ inches. It is equipped with supplementary lenses and is designed, also, for photography of body cavities. The price complete with leather carrying case is $150. Further information will be supplied by the manufacturer.

A new darkroom lamp and filter outfit has been announced by the Agfa Ansco Corporation. It includes a 3¼ x 4¾ inch Safelight Lamp housing and socket, one green, one yellow-green, and one red safelight. This company now manufactures a speedgun designed for synchronized flashbulb pictures with the Memo Camera.

Mazda Lamps. General Electric Co., Nela Park Engineering Department, Cleveland. Bull. LD 1. 1939. 66 pp. 30c. — Photographers will find the section on color temperature with its colored charts showing the electromagnetic system, radiation of Mazda lamps, efficiency and energy distribution of timely interest. Data shows the relation of the energy spectrum of the lamps to the sensitivity of the eye and of the photographic emulsion. Much information is offered on the history of lamp development, operating data and lamp economy which has hitherto been available only to the illuminating engineer. Operators of studios

using considerable current could use the data for reducing overhead. Special bulbs such as the mercury arcs and fluorescent bulbs are described with full technical information on operation and limitations.

The Eastman Kodak Company has prepared data books on several of their products. The books on Eastman Photographic Papers, Kodak Films, and Kodachrome Films are particularly valuable. They contain much technical information on the characteristics of these materials which is of great value to the advanced photographer.

The 1940 edition of the Filmsound Library Catalog is now available. It contains 92 pages and lists sound films on a vast variety of subjects, both for entertainment and teaching. Bell & Howell of Chicago will be glad to send a copy of the new film book without charge to all owners of 16 mm. sound projectors upon registration in the Bell & Howell files. To register it is necessary only to state the make of equipment and its purchase source. This company also announces that it is prepared to equip with special micro-motion speed dials any of its Film 70 16 mm. Cameras or Filmo 8 mm. operating in the 16— to— 64 speed range. Motion study experts use the metric system, with the minute as the unit of time. Therefore, Bell & Howell cameras equipped for this work have micro-motion speed dials calibrated to operate the instruments at 500, 1,000, 2,000, 3,000, and 4,000 frames per minute, instead of the conventional "per-second" calibrations. Two types of dials are available — one graduated exclusively for micro-motion work, and the other calibrated both for these special speeds and for conventional camera speeds. In analyzing micro-motion pictures, each frame is viewed as a "still," and it is necessary to determine accurately the number of frame in each analytical sequence. Therefore, there must be some method of moving the film through the projector one frame at a time. This is easily accomplished on standard Filmo projectors simply by turning the hand-setting knob. Bell & Howell is also providing a special frame counter and hand crank, which may be attached to any 8 or 16 mm. silent Filmo projector. It is instantly disengaged for regular projection.

Kodachrome arc projection is much improved by the use of a new type of carbon which is said to produce illumination much higher in red ray content than heretofore available in arc lamp projection. Further information about this new carbon can be obtained from the Bell & Howell Company, Chicago, Illinois.

ASSOCIATION NEWS

B. P. A., INC.

The Biological Photographic Association is now incorporated under the laws of New York State.

We owe a vote of thanks to Dr. Oscar Richards and to the Spencer Lens Company for the work done by their legal department in preparing and putting through the necessary papers.

SUSTAINING MEMBERS

The Fleischmann Laboratories
810 Grand Concourse
New York, N. Y.

George H. Semken, M.D.
16 West 85th Stret
New York, N. Y.

Louis Paul Flory
Boyce Thompson Institute
for Plant Research
Yonkers, N. Y.

Anne Shiras
University Office
Magee Hospital
Pittsburgh, Pa.

Leonard Perksie
Defender-Photo-Supply Co.
142 West 24th Street
New York, N. Y.

Lloyd Varden
Product Information Dept.
Agfa Ansco Company
Binghamton, N. Y.

Arthur Proetz, M.D.
Washington University
St. Louis, Mo.

AS OF 1940

A FEW statistics about your Association may be of interest to you. The present membership (not counting non-member subscribers) numbers just under 300 (292 to be exact) and is distributed among 38 states, the District of Columbia, Canada, the Canal Zone, and several foreign countries. Ten states have come in since the last count was published (Vol. V, No. 2, December, 1936, P. 91) and we still have ten to go. The missing states are: Alabama, Idaho, Kentucky, Mississippi, Nevada, North Dakota, South Dakota, Rhode Island, Vermont and West Virginia. As to countries outside the United States and Canada, the following are represented: Czechoslovakia, Denmark, England, New

Zealand, South America and South Africa. 3% of our members are distributed in these countries. Local distribution shows 25% in New York State, 19% in Pennsylvania, 8% in Massachusetts, 4% in Illinois and Connecticut, and smaller percentages in the remaining states.

Professionally our members are divided into the following classifications:

Full Time Scientific Photographers (Mostly in photographic departments of scientific institutions)	20%
Free-Lance and Commercial Photographers (Professionals with scientific leanings)	14%
Members in the Medical Sciences (Doctors and their assistants, discounting full-time photographers)	44%
Members in the Biological Sciences (Biology, Zoology, Entomology, Wild-life, etc.)	14%
Amateurs	3%
Members in the Photographic Industry	5%

RESOLUTION SENT TO THE SURGEON GENERAL

The following resolution was drawn by a committee appointed at the Pittsburgh Convention, and sent to the Surgeon General of the United States Army, over the signatures of the President, the Vice President and the Secretary of the B.P.A.:

"WHEREAS, the art of clinical illustration has made great and important advances in the past quarter of a century; and

"WHEREAS, clinical illustration is indispensable as an aid in scientific investigation and in the preservation of valuable clinical material; and

"WHEREAS, clinical illustration would be of great value to the medical division of the United States Army in time of war; and

"WHEREAS, there has been organized since 1931, a group of biological photographers and artists known as the Biological Photographic Association, whose aim is to further the study of photography in relation to the biological sciences and to improve its technique;

"THEREFORE, BE IT RESOLVED:

"That the Biological Photographic Association offer its full cooperation to the United States Army in the development of Biological illustrative units for use in time of war."

The members of the committee were Mr. Creer, Mr. Julin and Mr. Morris. Mr. Creer has been in touch with the Surgeon General for some time about the progress of organized clinical photography in the Army Medical Division and the matter of our possible cooperation has been discussed at several meetings.

New Members

The following new members are welcomed to the Association:

Abbott, Berenice (*Henry Lester*), 50 Commerce Street, New York, N. Y.

Alexander, C. M. (*Pittsburgh Chapter*)********, 708 Commonwealth Bldg., Pittsburgh, Pa.

Allard, Albert H., Jr., Box 2024, Ancon, Canal Zone

Bailey, L. J. C., M. D., 716 First National Bank Bldg,. Greensburg, Pa.

Cameron, William J., Glenridge Road, Schenectady, N. Y.

Corachan, Manuel, M. D. (*Herman de Las Casas*), Clinica Razetti, Caracas, Venezuela

Corrigan, K. E., Ph.D. (*Frank N. Ruslander*)**, Harper Hospital, Detroit, Mich.

DeCarlo, John, M.D., 1629 S. Broad St., Jefferson Medical School, Philadelphia, Pa.

Demerath, L. (*R. P. Creer*)********, Cameron Surgical Specialty Co., 666 W. Division Street, Chicago, Illinois

DeLucchi, Milton R. (*Louis Schmidt*)******, Box 121-A, Route 2, Upland Road, Redwood City, Calif.

Elle, Walter G. (*Arthur Proetz*), 3427 Washington Blvd., Barnard Free Skin & Cancer Hosp., St. Louis, Mo.

Enzer, Norbert, M.D. (*Leo Massopust*), Mt. Sinai Hospital, Milwaukee, Wisconsin.

Evans, Katherine A. (*Chester O. Henry*), 5915 Elgin Avenue, Pittsburgh, Pa.

Fahey, Joseph A., M.D. (*John F. Adams*), Buffalo General Hospital, Buffalo, N. Y.

Falkenstein, Alfons P., M.D., Mt. Sinai Hospital, Chicago, Illinois .

Farris, Edmond J., Ph.D. (*Oscar W. Richards*)****, The Wistar Institute of Anatomy and Biology, 36th St. and Woodland Ave., Philadelphia, Pa.

Freivogel, Dr. Hans (*J B. Haulenbeck*), Flushing Hospital, Flushing, L. I., New York

Gaggin, Helen (*Dr. Elizabeth Ross*), Shadyside Hospital, Pittsburgh, Pa..

Garbutt, Raymond J., D.V.S. (*Adoplh Marfaing*), Hospital of A.S.P.C.S., New York City

Gilberg, Albert G., 3171 Madera Avenue, Oakland, Calif.

Goldman, Douglad, M.D., Longview State Hospital, Cincinnati, Ohio

Gongalez, R. Baquero, M.D. (*Herman de Las Casas*)*, Clinica Gongalez Lugo, Caracas, Venezuela

Hildreth, H. Rommell, M.D. (*Arthur Proetz*)*, Washington University, Opthalmology Department, St. Louis, Mo.

Hamilton, Edward, College of Medical Evangelists, Los Angeles, Calif.

Johnson, Geo. Fiske, Penna. State College, State College, Pa.

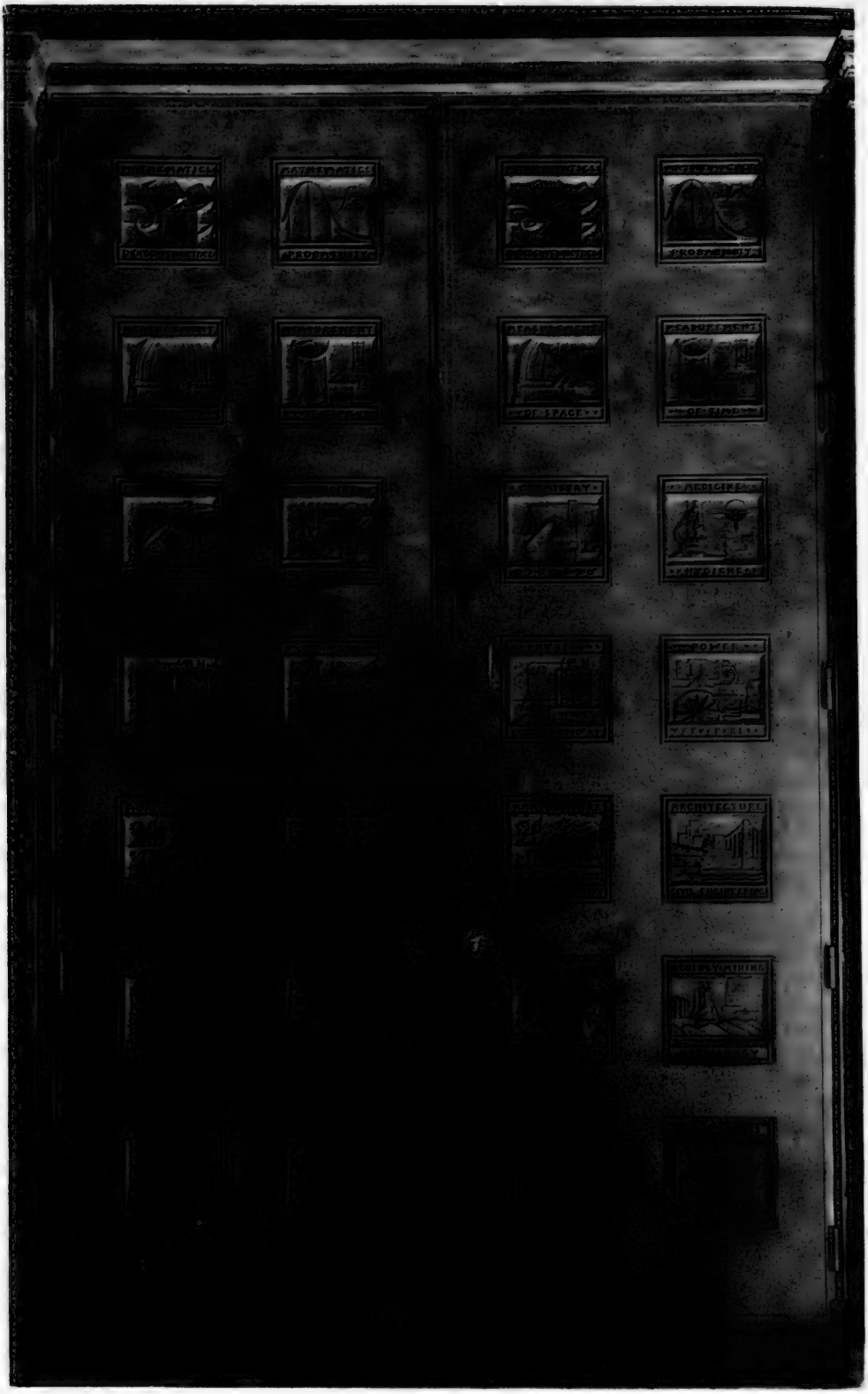
Johnson, Trois E., M.D., State Colony & Training School, Alexandria, La.

Lamoreux, W. F., Ph.D., Dept. of Poultry Husbandry, Cornell University, Ithaca, N. Y.

Lindberg, Ludwig, M.D., Tucson, Ariz.

Lore, John M., Jr. (*Albert Sadler*), 4704 Delafield Avenue, New York, City
Lorenc, Aloysius N. (*Louis Schmidt*)******, University of Notre Dame, Notre Dame, Indiana
Lorenz, Jean (*R. P. Creer*)*********, 1300 N. Dearborn St., Chicago, Illinois
Lowe, Edward T., Paramount Studios, Hollywood, Calif.
McIver, Robert Boyd, M.D. (*Clayton E. Royce*), 1108 Greenleaf Building, Jacksonville, Florida
Miller, Joseph E. (*David W. Dick*), 136 Church Hill Road, Bridgeport, Conn.
Mosiman, R. E., 711 Stimson Bldg., Seattle General Hospital, Seattle, Wash.
Myers, E. E., M.D., Myers Clinic Hospital, Philippi, W. Va.
O'Daly, J. A, M.D. (*Herman de Las Casas*)**, Clinica De Vellard, Caracas, Venezuela
Palmer, Vincent, 59 Randolph Avenue, Milton, Mass.
Parker, Harry W. (*Louis P. Schmidt******* and Stella Zimmer*), 3812 Gladys Avenue, Chicago, Illinois
Peretti, Lucretia C. (*F. R. Harding*)*, 234 Marlborough St., Boston, Mass.
Pijper, Adrianus, M.D., 57 Celliers Street, Pretoria, S. Africa
Porter, Eliot F., 10 El Zaguan, Santa Fe, New Mexico
Power, H. A., M.D. (*Dr. Mortimer Cohen*), Magee Hospital, Pittsburgh, Pa.
Reynolds, Rose M, University of Neb. Medical College, Omaha, Nebraska
Rhamy, B. W., M.D., Ft. Wayne Medical Lab., Ft. Wayne, Indiana
Rogers, Nickerson (*L. B. Brown*), 285 Columbus Avenue, Boston, Mass.
Ross, Elizabeth, M.D., Shadyside Hospital, Pittsburgh, Pa.
Royce, Clayton Elbert, M.D., The Clinical Lab., Jacksonville, Fla.
Sadow, Arnold (*F. R. Harding*)**, 39 Columbia Rd., Dorchester, Mass.
Schwab, Mack W. (*L. B Brown** *and W C. Lown*), 44 E. Springfield, Boston City Hospital, Boston, Mass.
Sislock, Thomas P., 1801 Bush Street, Greens' Eye Hospital, San Francisco, Calif.
Smith, Voca L. (*Dr. C. E. Royce*), St. Vincent's Hospital, Jacksonville, Florida
Smith, Arthur L., Zoology Lab., McGraw Hall, Cornell University, Ithaca, N. Y.
Stern, Howard Seymour, M.D., Univ. of Arkansas School of Medicine, Little Rock, Ark.
Town, F. R., M.D. (*Leo Massopust*)*, Isabelle County Health Unit, Mt. Pleasant, Mich.
Varden, Lloyd E., Agfa Ansco Corp., Binghamton, N. Y.
Watson, W. V., M.D., 170 St. George St., Toronto, Ont.
Weeks, James A. (*Louis Schmidt******** and J. B. Haulenbeck**), 234 E. 58th Street, New York, N. Y.
West, Frederic B., M.D., 5666 Sunset Blvd., Los Angeles, Calif.
White, Frank (*W. C Lown*)*, 182 Morrison Ave., Somerville, Mass.
Wirts, C. W., M.D. (*Joseph Poppel*), Jefferson Medical School, Philadelphia, Pa.
Yoffe, S. M., M.D., 504 Second Street, Harrisburg, Pa.
Zlobin, George, 611 Van Sicklen Avenue, Brooklyn, N. Y.

Asterisks denote the number of new members brought in by each sponsoring member who has brought in more than one



UNIV. OF MICH.

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THE BRONZE DOORS*

PHILIP FOX†

"SCIENCE discerns the laws of Nature. Industry applies them to the needs of Man." So reads the inscription, in bronze letters more than two feet high, which extends around the Central Rotunda of the Museum of Science and Industry, Chicago.

The great bronze doors, measuring each 14 feet 8½ inches by 4 feet 6 inches and weighing 1800 pounds, in the main portal to the Museum have fourteen panels measuring 13½ by 15½ inches. Originally the panels were to bear identical conventional figures but during the period of construction the idea presented itself to substitute various figures, each designed to represent a department of the Museum by presenting some important descriptive symbols. The several Curators participated in choosing the features to be portrayed, but the final designs were largely the work of Mr. Percy Lund, Artist, and Mr. Leonard Crunelle, Jr., Sculptor, of the Museum staff. They were cast by The General Bronze Company.

Archimedes expressed the wish that over his tomb should be graven the geometrical figure of a sphere inscribed in a cylinder. He considered his demonstration of the ratio of the volumes of the sphere and circumscribed cylinder his greatest achievement. In similar spirit, we have sought to select significant figures, equations, instruments, machines, legends to represent the subjects within the scope of the Museum. No human figures appear in the designs but in all of them are found the concepts and achievements of human thought.

* This article is reprinted by permission from NOTES, 1:6, Feb. 1939, published by the Museum of Science and Industry, Jackson Park, Chicago, Ill.

† Director, Museum of Science and Industry, Chicago.

EXPLANATION OF FRONTSPIECE

The museum doors were photographed at night with artificial light in order to bring out the panels in relief.

MATHEMATICS

Most fundamental of these concepts are those formalized in Mathematics and those of Time and Space inherent in all thought. Formal mathematics, as exemplified by Geometry, is represented by a panel in which the central figure is a construction for the proof of the Pythagorean theorem shown against a logarithmic spiral as a background. "Eculid alone has looked on Beauty bare." Below, suggesting that the universe is constructed on mathematical principles, or that mathematics is a universal language is the Greek inscription: "God always geometrizes." The companion to this panel bears the Normal Frequency Curve. The significance of the probability function is stated by Laplace, "It is remarkable that a science (probabilities) which began with consideration of games of chance should have become the most important object of human knowledge." Not certainly, but a state of probabilities is the way of common life. Included in the design is a form of the Probability Integral. The coefficient, which affects the scale, is omitted. It would have been better to have retained it, for the presence in it of the symbol Π demonstrates that Π has broader significance than simply expressing the ratio of the circumference of a circle to its diameter.

MEASUREMENT OF SPACE

Man is restricted in his direct measurements to the region on or near the Earth's surface. About him stretches indefinite space which can be measured only by the light which traverses it. The astronomical telescope in its dome is symbolic of man's effort to plumb this limitless, inaccessible region, to determine the scale, and gain understanding of the universe of which he is a part. Recognition of boundless expanse is symbolized by the sign for infinity, ∞.

MEASUREMENT OF TIME

All measurement of time depends on motion, whether it be the beat of the pulse, a burning candle, shifting shadows, or oscillating pendulum. The sun dial is typical of early devices for observing the uniform rotation of the Earth as revealed by shadows of gnomons or styles in sunlight. The hour glass represents early efforts to attain uniform mechanical motion rendering timekeeping independent of the time of day and weather. In the pendulum clock these attempts reach their highest development; the best of them rival the uniformity of the

Earth's rotation. The symbol of infinity used as a decoration in the legend signifies that time has neither beginning nor end; our day is but a moment in eternity.

Chemistry

Chemistry as a science emerged from ancient alchemy. The retort, over the flame, from which drops are being distilled dates from ancient times but still finds an important place in the modern laboratory. Along the bottom of the panel are the alchemists' symbols for the metals, borrowed from astronomical signs for the planets, but here signifying gold, silver, mercury, copper, lead, tin, and iron. The balance and weights symbolic of quantatative methods are both ancient and modern. Strictly modern, however, is the chemistry of the carbon compounds which is represented by the hexagon, symbol of the benzene ring.

Medicine

The serpent-twined staff of Aesculapius is the oldest symbol of the medical sciences. It projects the profession back into the age of fable. The mortar and pestle with the classical ℞, ancient also, stands as the symbol for pharmacy. The modern microscope and x-ray tube, revealing structures, normal or pathological, unseen by the unaided eye represent modern research on the human body, in health and disease.

Physics

The vastly diversified field of physics is symbolized by the apparatus used to establish one of its fundamental laws, the relationship between Work and Heat. Joule used the calorimeter and the weight-driven paddle wheel to derive the result embodied in the equation $W = JH$, the First Law of Thermodynamics, a corner stone of modern physics. The expression $h_v = E = mc^2$ is made up of two equations, one representing the relationship between quantum energy and frequency; the other that between mass and energy according to relativity theory.

Power

Man supplements his own strength by five general means: by harnessing animals, the wind, falling waters, expanding steam, or power of other heat engines. These are represented here by a simple recipro-

cating steam engine and water wheel. Only now do the internal combustion engines, supreme in airplanes and automobiles, begin to challenge steam in railroad transportation and ships. Of the four general methods of transmitting power; mechanical, hydraulic, pneumatic, and electrical, the last stands supreme. It is symbolized by Edison's bipolar dynamo of 1880, which properly marks the beginning of the "electric power era." The legend Fv = P = EI defines power in two aspects. In mechanics, Power = Force × Velocity. Where power is transmitted electrically, it can be represented in certain cases by Power = Volts × Amperes (P = EI), applicable literally for direct current or single-phase alternating current of unit power factor, and in other forms the product EI appears as a part of a complex expression. One could wish that an additional symbol, the diagram for the Carnot cycle expressing fundamental principles of thermodynamics, had been incorporated in the panel.

AGRICULTURE, TEXTILES, AND FORESTRY

To symbolize these most fundamental industries — providers of food, clothing, housing, — three elements appear: the plow, one of the most ancient and most generally used agricultural tools; a Saxony spinning wheel by which wool or other fibers are twisted into threads, made ready for the loom; and a tree, the crop of the forester and the raw material of the lumberman and the paper and pulp industries.

ARCHITECTURE AND CIVIL ENGINEERING

The contrast between the golden age of Greek architecture and that of present day America is represented by a fragment of a Greek temple of 5th Century B.C. and a background of modern steel-skeletoned skyscrapers. The earlier era with limited available materials attained perfection of form; the latter, experimenting with new materials sending structures skyward, is striving likewise for beauty of design. In the background a modern suspension bridge, with cables of steel wires, supported from lofty towers, stretches in broad and lofty span, a dramatic symbol of achievement in Civil Engineering.

TRANSPORTATION

Travel on water, land, or in the air is symbolized by an ocean liner in head-on approach, a Diesel electric train speeding on its steel

rails, a passenger automobile on the highway, and a modern transport plane in full flight. The designs with stream-lined bodies illustrated the modern trend and indicate speed.

Geology and Mineral Industries

These diverse and earthwide fields dealing with the structure of the earth and its mineral resources, are symbolized by a typical view of a large steel plant with stock piles of raw materials, iron ore, limestone, and coke; and an operating blast furnace. The product is an essential to modern life; tools, instruments, engines, machines, frames of sky-scrapers, hulls and frames of ships, cannon, cutlery, wire, and rails.

Communication

Prominent in the central portion are the poles which are familiar features of every landscape, typifying the most common forms of communication: telegraphy and telephony. Equally prominent is the radio tower symbolizing instantaneous, world-wide dissemination of news and entertainment. The S-O-S- suggests radio's most dramatic use. More primitive means of communication are represented by puffs of smoke from a distant hill. The message in semaphore code reads, "Quo Vadis."

Graphic Arts

An early wooden hand press, suggestive of Gutenberg and early printing technic and the use of movable type, indicates the influence of printing in spreading knowledge and promoting civilization. The influence of Caxton who produced the first book printed in English "The Recuyell of the Historyes of Troye" is acknowledge by his master-mark. The elements of written speech are represented by letters of the alphabet and numerals.

The great doors serve a dual purpose: portals to the building and to the thought within.

MICROCINEMATOGRAPHY OF THE MOTILE ORGANS OF TYPHOID BACILLI

ADRIANUS PIJPER*

Purpose of Paper

MY PURPOSE is to describe, for the first time, how the motile organs (flagella) of typhoid bacilli have been filmed in their natural state by means of a special sunlight-darkground technic.

Microcinematographic pictures of moving bacteria have been made before. [1,2,3] My point is that by suspending the bacteria in solutions of gum or similar substances, these authors did not deal with motile organs in their natural state. With their method the gum precipitated on the bacteria and flagella, thus surrounding them with a sheath of gum. The thickened flagella facilitated photography, but they had become too stiff to function properly. Therefore the results were artefacts, just like the still photomicrographs of other authors [4,5] who used similar methods. They should be interpreted in the light of my still photomicrographs of typhoid bacilli in clear broth or water [6,7,8] and of my 16 mm. motion picture film to be discussed herein.

In clear broth or water I found the motile organs or flagella of typhoid bacilli to be so fine that they could hardly be made visible, and certainly not photographed, let alone filmed, unless sunlight was used as the source of light.

Motile Organs (Flagella) of Typhoid Bacilla

I have shown [6,7,8] that each individual typhoid bacillus has two flagella, attached near the middle of its body. They are extremely fine threads, wound like a spiral. In action they revolve around their own (imaginary) axis, and communicate this revolving motion to the body of the bacillus, pushing it forward at the same time. The forward motion stretches and elongates the flagellar spirals, they meet at the tail end of the bacillus, become wound round one another, and produce the appearance of a long straight tail. A fast swimming bacillus thus resembles a tadpole. During rest the flagella become shorter spirals

* Received for publication January 22, 1940, from the author's private laboratory, Pretoria, South Africa.

1 Neumann, F.: Centralbl. Bakt. Abt. I, Orig. 109, 143, 1928.
2 Loveland, R.P.: J. Biol. Photog. Assoc., 1:128, 933.
3 Loveland, R.P.: Photomicrography, 13th ed., Eastman Kodak Co. 1935.
4 Neumuller, O.: Centralbl. Bkt. Abt. I, Orig. 102, 90, 1927.
5 Wei, H.: Chinese Med. J., Suppl. 1, 135, 1936.
6 Pijper, A.: Centralbl. Bakt. Abt. I, Orig. 118, 113, 1930.
7 Pijper, A.: Centralbl. Bakt. Abt. I, Orig. 123, 195, 1931-32.
8 Pijper, A.: J. Pathol. Bacteriol., 47:1, 1938.

again, with broad windings. They may then separate or they may not, and a resting bacillus accordingly shows one or two short broad spirals, on the side of its body, usually extending at an angle of about 45 degrees. A return of activity again stretches the spirals. There are alternate periods of rest and activity. When twisted around one another the flagella hold the bacillus in a fork. A sudden reversal of the direction in which the flagella revolve may occur, causing the bacillus to go in the opposite direction. Thus the head has become the tail.

Gum was added to suspensions of bacteria by previous authors [1,2,3,4,5,9,10] to increase viscosity which would slow down the bacteria mechanically. Slowing down occurred, but chiefly because the gum, for reasons of the colloid chemistry involved, became absorbed on the bodies and the flagella. The gum-coated flagella became stiff, could not revolve freely and did not become stretched out. They remained stationary at an angle of about 45 degrees from the body of the bacillus, as the pictures of these authors show. Thus photography of the thick slow flagella was comparatively simple, but somewhat misleading. With proper interpretation, however, the pictures can be used for the study of bacterial flagella. They, at any rate, show that each individual bacillus has two flagella.

I have found that it makes no difference whether one studies typhoid bacilli or proteus bacilli. The flagellar arrangements are the same. Proteus bacilli can be a little more misleading, especially in gum solutions, because of their tendency to hang together, in long aggregates, which consist of a number of individual bacteria, all provided with two flagella, but giving a superficial impression of one long bacillus with a large number of flagella.

My contention that in gum solutions flagella become coated with a sheath of gum is easily proved. If such a preparation is left for a couple of days, the sheath breaks up into small granules, which dance up and down very thin spiral flagella, and eventually fly off, leaving the thin spiral flagella which I have seen and photographed. [7,8]

My present film then shows typhoid bacilli with their motile organs or flagella in their natural state: the fast moving bacilli exhibit tails and nothing else.
by the drying process play havoc with the distribution of tails, flagella

The traditional pictures of dried, fixed and stained flagellar preparations are no argument against my observations. The currents generated

[9] Loveland, R.P.: J. Opt. Soc. America, 22:161, 1932.
[10] Neumann, F.: Centralbl. Bakt. Abt. I, Orig. 96, 250, 1925.

and bacillary bodies, and the result is pure artefact, not to be compared with the orderly aspect of the bacilli photographed with my method.

TECHNIC OF SUNLIGHT DARKGROUND MICROCINEMATOGRAPHY

(a) *Source of Light*

Sunlight is still the light source of highest intrinsic brilliancy available to the microscopist. I have used it exclusively. A Zeiss heliostat stands outside the laboratory on a glass plate which can be raised or lowered along four metal upright tubes, figure 1. The metal stand is five feet high and stands on a block of concrete on which meridians are painted as alternating black and white stripes. These serve to adjust the shaft of the heliostat at whatever height the glass plate may have to be placed in order to suit the season of the year. The final adjustment of the heliostat is leveled by means of three levelling screws. The heliostat mirror is then swung round so as to send a beam of sunlight through a sliding door in a suitable direction into the laboratory, as illustrated in figure 1. It is there seen to impinge upon a paper screen surrounding the collector lens of the microscope. I do without the auxiliary mirror supplied with the heliostat, as every reflection reduces the amount of light. The heliostat mirror, however, by itself has rather a limited range of action, the direction of its beam is chiefly determined by its position, and a good deal of shifting about may be necessary to use it to best advantage. Full provision is made for this by the set-up of figure 1.

The collector lens on which in figure 1 the beam of sunlight is seen to impinge, has a diameter of 10 cm., and a 2 meter focus. It is attached to the microscope stand by means of a long metal tube, and its heart lies in the axis of the microscope. As it moves with the microscope it is always centered. Its focus lies in the opening of the darkground condenser, which is completely filled with light. The microscope mirror has been taken off, in order to save light.

(b) *Microscope Stand*

As the direction of the beam of sunlight from the heliostat changes from day to day, provision had to be made in the set-up of the microscope for great mobility. This is illustrated by figures 2 and 3. A heavy metal tripod carries the whole outfit. This can be moved about over the

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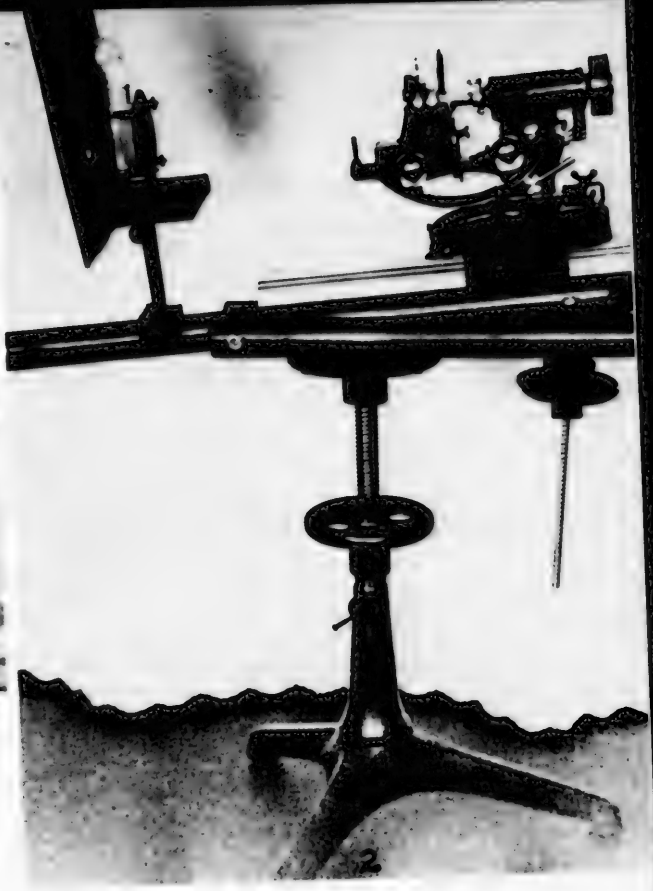
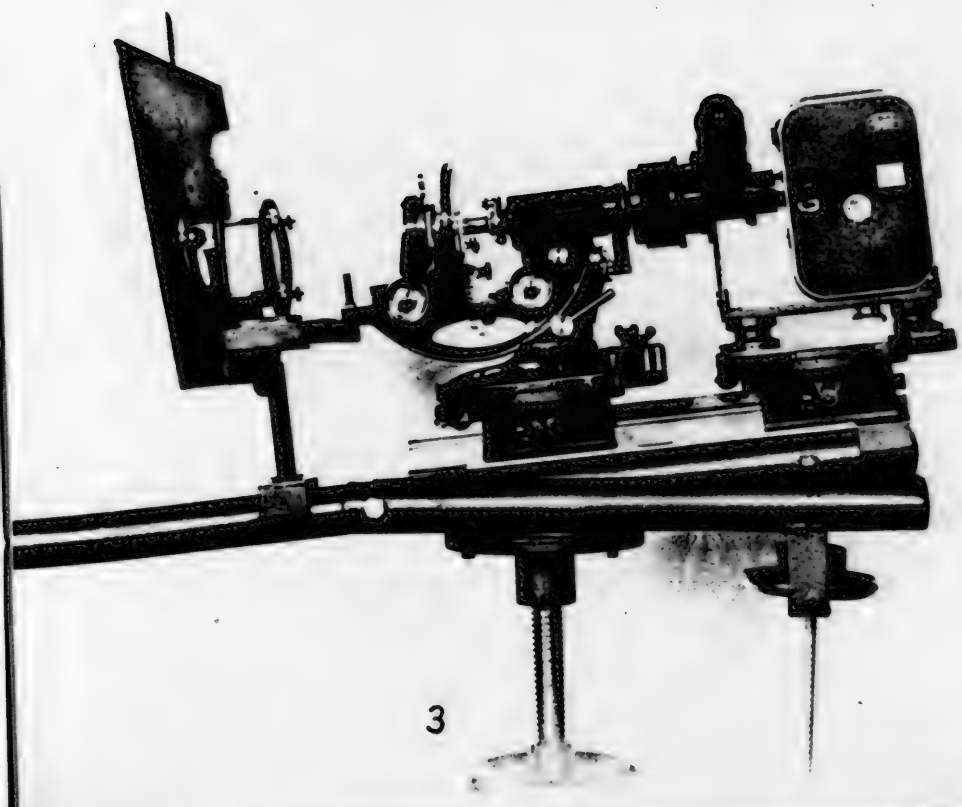
EXPLANATION OF FIGURES

Figure 1. Heliostat in position outside laboratory.
Figure 2. Sunlight darkground microscope in position for visual work.
Figure 3. Apparatus in position for taking motion pictures.

1



2



3

UNIV OF MICH.

floor of the laboratory, which is of concrete, covered with thick linoleum. A wheel and screw spindle allows for raising or lowering the round top of the screw spindle. To this round top two parallel heavy metal tubes are permanently fixed, the front one of which is visible in the photographs. In between these two tubes there is another of the same caliber, which is very long, and at its far end on the left, not visible in the photographs, carries the collector lens mentioned. This long metal tube can be tilted by means of the wheel and screw spindle shown on the right hand side, and its pivot is a bolt which passes through the two supporting shorter metal tubes at their left end. The long metal tube also carries a small table which supports a water cooler and to which a thin metal screen is attached which protects the observer's eyes from the sunlight.

A 50 cm. triangular steel optical bench is firmly attached lengthwise to the upper surface of the right hand side of the long metal tube. The microscope and the camera can slide along this optical bench by means of the usual saddles.

Provision has thus been made for horizontal, vertical and tilting movements, but at all times the collector lens, the microscope and the camera remain centered.

The microscope stand proper is from Beck, and has the following useful features; easy and quick centering of substage condenser and objectives, and exceptionally delicate fine adjustment, which moves the objective only, not the whole tube.

The usual procedure is first to lead the beam of sunlight through the collector lens into the microscope. This is done by mutually adjusting the heliostat and the microscope stand in the morning and they can then be left for the day. As the heliostat is not perfect, minor adjustments to the microscope stand may become necessary during observations. The position of the focus of the beam of light in relation to the opening of the substage condenser must be watched constantly from the observer's end through a dark black mirror attached to the back of the protecting screen. For visual work the microscope is moved to the far end of the optical bench, as in figure 2. It is firmly clamped to a heavy sole-plate which carries a saddle at its under surface. For filming, the microscope is moved forward and the camera placed on the optical bench as shown in figure 3. The camera is fixed to a similar sole-plate which also carries a saddle. The saddles can be clamped in position. The sole-plates of both microscope and camera make provision for the exact centering of the two pieces of apparatus. Once this has been done they will remain in correct position for many weeks, and

when anything has to be filmed, it is only a moment's work to slide down the microscope and slide on the camera. There is of course a light-tight lock between microscope and camera. Visual work is usually done with one or two water-coolers, for filming they are usually taken away, again to save light.

Some parts of the stand were supplied by Zeiss, the others have been made locally. The assembling of the apparatus has also been done locally.

(c) *Optical Equipment*

The entire optical equipment is Zeiss. I have used their Siedentopf cardioid darkground condenser. In order to get the thin tails of the typhoid bacilli to radiate enough light to make an impression on the film, I found it necessary to use as low a magnification as was consistent with obtaining sufficient detail. For this purpose I found the oil-immersion apochromat 35 x, N.A.O.85, with the photographic eyepiece 4 x the most suitable combination. (A still more effective combination would be the oil-immersion apochromat 60 x, with iris, N.A.1.O with an eyepiece 2 x, but such an eyepiece has not yet been made).

I have found the combined glass-mica microscope slides as supplied by Zeiss, from which one can split off a thin layer of mica several times, each time leaving an unscratched and dust-free surface, of great advantage. Ordinary glass slides, however carefully prepared, always exhibit too many blemishes.

The beamsplitter which I used, is the one made by Zeiss for a 35 mm. camera. It provides suitable extra-magnification. A disadvantage is, that too much light reaches the observer's eye, and too little to the film. As is shown in figure 3, I did not use it in the vertical position, but at an angle. This is done for convenience in observing the preparation. One must of course remember that in this position the field observed in the beamsplitter does not quite correspond to that which reaches the film.

(d) *Camera*

My set-up, as detailed above, needed mobility on account of the variation in the direction of the beam of sunlight that occurred from day to day. This rather precluded the addition of a separate motor unit

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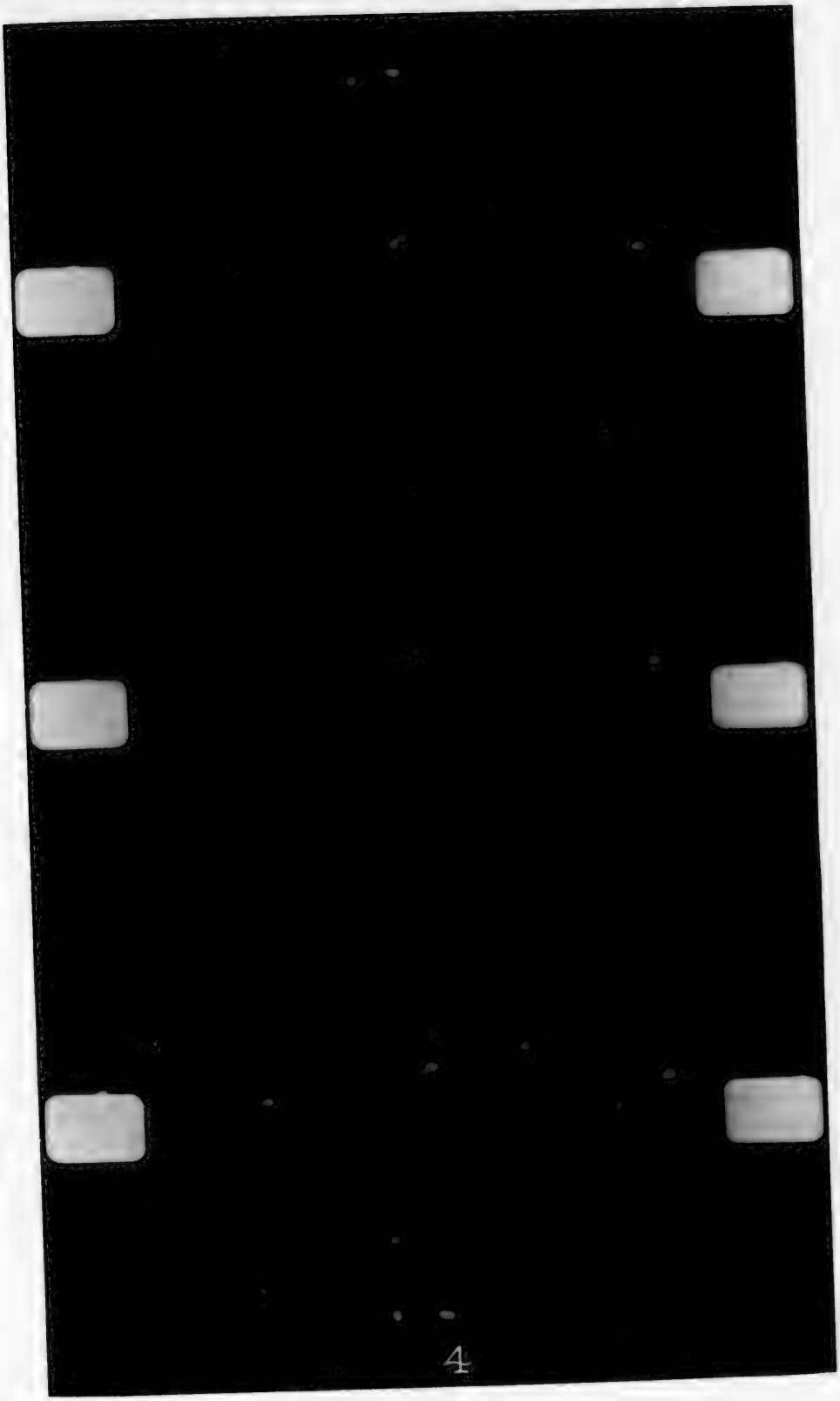
EXPLANATION OF FIGURE

Figure 4. Part of the motion picture film. Note oval bacillary body in center, with tail.



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to drive the camera, as suggested by most authors.[9,11,12,13] The Zeiss Movikon film camera that I have used has a very quiet clockwork motor. Although clamped to the same optical bench as the microscope (there was of course no physical contact between the camera and microscope tube), this camera did not communicate any vibration to the microscope. The camera was run at 12 frames per second, with the shutter opening at 180 degrees. At this rate the time of exposure was 1/25th of a second. Shorter exposures and higher speeds have so far not been tried for filming, but I have noticed that even at a speed of 24 frames a second no visually appreciable vibration occurs. The Movikon film delivers 20 feet of film for every complete winding of the spring. This is ample for most cases, and with due care one can avoid the awkward situation — that at a critical moment there is no more film available.

(e) *Film Material*

The very exacting nature of my work demanded film material of extremely high speed, good contrast and absence of graininess. After getting no results, or very indifferent results with various types of films, including Kodak Supersensitive Panchromatic, I found what I wanted in Kodaks new film, Super-XX Panchromatic. I still live in hope that for the microcinematography of still finer structures which so far the human eye alone can record, a more sensitive film will yet be produced. My present motion picture could not posibbly have been made without Cine-Kodak Super-XX.

The Motion Picture

Figure 4 is a much enlarged print of a short section of my motion picture. I have selected a part where a bacillus appears with a particularly well-developed tail. Near the body the tail is invisible, because the tail becomes untwisted and forms the "fork," which consists of threads only half the thickness of the tail, revolves more rapidly, and may not be in focus. The whole film consists of a succession of fast moving bacilli, sometimes several in one field, usually going rapidly across it, occasionally swimming in a circle within the field. Tails are seen to curl when motion is suddenly reversed, and to curve as to steer the

[11] Kingery, H.M.: J. Biol. Photog. Assoc., 2:130, 1934.
[12] Roger, H.: J. Soc. Motion Picture Engineers, 24:475, 1935.
[13] Scheminsky, F. Photogr. Praktikum, Wien, Julius Springer, 1930.

bacillus when turning a corner. It is curious that these typhoid bacilli, even in a very crowded field, very seldom bump into one another. They pass one another at very close range without visible disturbance, which shows that there are no additional motile organs on the sides of the body which the microscope has not revealed.

The work is being continued and a motion picture which will analyze and illustrate the phenomena of bacterial agglutination is well under way.

ACKNOWLEDGEMENTS

This work is a continuation of my researches on the microscopic aspects of bacterial agglutination for which I received a grant from the Research Grant Board of the Union of South Africa.

I take this opportunity of expressing my sincere thanks to Mr. L. B. Poole, of the local firm of F. A. Poole (Pty) Ltd., Structural Steel Works, for his expert advice, and his unfailing enthusiasm and efficiency in building my microcinematographic apparatus.

SUMMARY

By means of a sunlight darkground microscope technic, which is described in detail, it was found possible to produce a 16 mm. motion picture of the motile organs of typhoid bacilli in their natural state and full activity. These motile organs which have not been seen before, are so fine that they can only be made visible by means of sunlight darkground methods.

USED PHOTO EQUIPMENT DIRECTORY

The Photo Equipment Directory, published at 3111 West Tuscarawas Street, Canton, Ohio, offers you a free advertisement of 25 words listing the things you wish to buy, sell or exchange. If more than 25 words are used, there will be a charge of 2 cents per word for each word over 25.

The Directory is published four times yearly, the next issue to appear late in June or early in July. It will list "cameras, lenses, tripods, lighting accessories, developing tanks, filters, movie projectors — in fact any of the many items used in photography." The charge is 25c per issue, or $1.00 for the year. An order form will be sent on request.

A NOTE ON PHOTOGRAPHIC RESOLUTION IN PRACTICAL PHOTOMICROGRAPHY*

R. V. DENT, F.R.P.S., F.R.M.S.†

IT IS curious that there seems to be no mention in the literature on photomicrography, of the connection between the photographic resolving power of emulsions and the resolving power of objectives. Is this because it is assumed that the photographic resolving power of emulsions is always in excess of that secured by the objective? If so, practical experience indicates that this is an assumption which is often not justified by results; the fact that photographic resolution in photomicrography is at times an important factor in securing the best results seems to be ignored.

The writer thinks the reason for this is clear. Text-books are written by authorities on the subjects, and such authorities assume that their methods of working will be followed by their students. When such methods are followed there is no question that photographic resolution, even of the older coarser-grained emulsions, was sufficient satisfactorily to care for the optical resolution secured by the objective in use. But there is an unfortunate tendency to wander away from the sound methods taught by Messrs: Barnard and Welch, Martin and Johnson, Spitta, Beck, Hind and Randles, Nelson, Conrady and other authorities on practical photomicrography, under the mistaken impression that a new day has dawned in photographing through the mircoscope because of the little gadgets which attach to the mircoscope and hold thereto a so-called miniature camera. Unless used with long extension tubes, these fitments must necessarily have a converging positive lens to reduce the size of the projected image otherwise fields would become too small.

Far be it from the writer to decry these small cameras. They serve a useful function, and for certain work are unique in their field. But it is a mistake to be under the impression that they can do anything and everything that the larger cameras can do. Further, to use a larger plate does not necessarily involve a complicated photomicrographic apparatus. Enlarging a photographic negative image does not *ipso facto* improve the image; therefore while a small image may *appear* sharper, in reality it is no sharper than the larger image which appears less sharp, provided both were taken under identical circumstances and

* Received for publication March 19, 1940.
† Associate in Scientific Photography, Henry Lester Institute of Medical Research, Shanghai, China.

printed the same size. It is notorious that small negatives which appear perfect in definition, often refuse to give equally perfect enlarged prints; other factors such as resolving power, density, thickness, graininess, physical defects, scatter, and contrast play a part when enlargements of several diameters are made. Admittedly these factors are being minimized in importance as emulsions are improved, but they are by no means, as yet, totally overcome. Therefore the assumption that small negatives enlarged will always give as good results as larger negatives either printed by contact or enlarged to a less extent, is one at which an experienced worker is likely to balk.

To follow the reasoning which impelled the writer to bring this matter to the attention of photomicrographers, and to optical experts more capable than he is to deal with the purely mathematical side of the question, let us start with actual experience which is common to most readers.

A "still" is made on 16 mm. film of a lantern slide of a tissue section. The section is a good specimen for photomicrography, whereas the former is not; it may serve its purpose, admittedly, but it does not stand comparison with the slide. But if we record only a portion of the slide on our 16 mm. film, then the photographic image on the 16 mm. film is likely to be similar in quality to the original. In the same way we can take a 16 mm. film of a few spirochaetes and secure good results, but if we attempt a large field we are not satisfied with the image produced. Thus, we increase our "extension" and use smaller fields.

A complicated tissue section is photographed on the 1½ x 1 frame (approximately) of a 35 mm. film; the result is definitely not as good in the final print as the same subject taken directly on a larger plate. But when we photograph high-power subjects — the smaller camera with converging lens reduces the image size, and enables us to work closer to the microscope and thus faster; results are good, if not over-enlarged in the printing.

These facts are common knowledge to experienced workers. They are in perfect accord with our generally accepted ideas that there is a limit to what we can expect our photographic emulsions to record clearly, for when we exceed the photographic resolving power by the optical resolution, we do not secure the full benefit of the optical resolution available. Indeed, this is the rule with modern lenses in most ordinary photography.

An interesting fact now comes to light. The higher the resolving power of the objective and total magnification, the less the resolving

power required from the photographic emulsion; in other words, the smaller the subject, the more do we remain within the resolving power of the plate or film. This important fact is nowhere mentioned in the literature, but surely is of great importance.

In order to have some theoretical basis for this statement, let us commence by asking what it is we wish to know, and then see how we can learn the answer:—

Wanted to know:— The number of lines per inch, resolving power of an objective, that are received per inch on the photographic plate at a given final magnification. Assumed that the N.A. of the objective is known and that it is used at maximum efficiency.

The following equations give us the answers:—

a/- $$\frac{\text{Photographic Image Size at 10″ Extension}}{\text{Magnification of Objective X Magnification of Eyepiece}} = \begin{cases}\text{Actual Size}\\ \text{of Subject.}\end{cases}$$

b/- $$\text{Resolution of Objective X Actual Size of Subject} = \begin{cases}\text{Resolution in lines}\\ \text{per inch at Focal}\\ \text{Plane on Plate.}\end{cases}$$

c/- Lines per Inch at Focal Plane on Plate at 10″ X Change of Plate Area by interposition of Positive lens = Lines per inch at new Focal Plane on smaller Plate.

Before we can proceed further we must know the resolving power of our objectives and our emulsions. They are as follows:

Table I

RESOLVING POWER OF OBJECTIVES

W/L 5269 A.U. (Apple Green)

N. A. of Objectives	Resolution per inch	Resolution per m.m. at 25.4
1.32	127.260	5.010
0.95	91.590	3.606
0.65	62.670	2.467
0.30	28.920	1.139
0.25	24.100	949
0.20	19.280	759
0.15	14.460	569
0.12	11.570	456

From Beck's "The Microscope" Part 2, pp. 66 to 69.

Table

OPTICAL RESOLUTION COMPARED

Objective	Mag. of objective	4″ Circle mag. at 10″ with X6 Eyepiece	Reduced Circle magnification with X10 Eyepiece	Actual Size of Subject
2 mm Apo.	X92	552	306.6	.00725
4 mm Apo.	X46	276	153.3	.01449
8 mm Apo.	X23	138	76.6	.02899
16 mm Apo.	X12	72	40.0	.05556
16 mm Achro.	X10	60	33.3	.06666
24 mm Achro.	X 6	36	20.0	.11111
32 mm Achro.	X 4.3	25.8	14.3	.15504
40 mm Achro	X 3.2	19.2	10.6	.20833

Table II

RESOLVING POWER OF EMULSIONS WITH RECOMMENDED DEVELOPERS

Emulsion	Developer	Lines per m.m.	Lines per Inch at 25.4
Microfile 35 m.m.	D 11	130	3,302
Panatomic X	D 76 (X)	55	1,397
Plus X Pan.	D 76 (X)	50	1,270
Super XX	D 76	45	1,143
Verichrome	D 76 (X)	40	1,016

(X) Said to give 5 to 10 lines per m.m. increased resolution with D.K. 20.
From Eastman Kodak Co's "Kodak Films: a data book on Negative Materials."

Having this data to work on, let us assume that we are working with a four inch circle at 10″. In actual practice we shall probably require an extension of 15″ to 20″ in order to get the entire field sharply in focus, thus increasing the magnification. But as this places the advantages still more with the larger plate and makes comparisons unnecessarily complicated, we will work at 10″ throughout, thus securing approximately the same magnification in our photograph as is seen visually at the eyepiece.

Using our formulae we arrive at the figures given by table III.

III

TO PHOTOGRAPHIC RESOLUTION

W/LA.U. 5269 Resolution available on Subject in Lines per Inch	Resolution on 4″ Circle at Focal Plane	Lines per Inch to be resolved on 4″ Circle	Lines per Inch to be resolved on Reduced Circle 4″ ÷ 3 Size	Resolution available lines per inch Panatomic X
923	923	231	693	1397
1327	1327	332	996	1397
1817	1817	454	1362	1397
1607	1607	402	1206	1397
1614	1614	403	1209	1397
2142	2142	535	1605	1397
2242	2242	560	1680	1397
2410	2410	602	1806	1397

This table will give food for thought to the proponent of tiny negatives when using low power objectives. Thus, theory appears to explain why the practical man finds that he does not obtain the same results with low power photomicrography, using miniature cameras, that he gets with a larger image such as a 3″ circle on a quarter-plate or a 4″ circle on a half-plate. Enlarging the image is not the answer. The answer is to have available, film of ultra resolving power, such as the "Microfile" but made suitable for general use. Doubtless it will come in time. At present, the miniature negative with the best standard fine-grain emulsion cannot compete with the larger plate on low-power subjects requiring fine definition.

No mention has been made of the circle of diffusion of the optical point or disc. For those workers who are interested, the following is the equation:

$$\frac{\text{Magnification}}{\text{Twice the Wave-length of Light} \times \text{N. A.}} = \text{Circle of Confusion}$$

Table IV shows the size (diameter) of this circle at various magnifications with various objectives. These figures constitute the measured magnification that the writer secures with the named objectives and X6 projection eye-piece at a working distance in all cases of 55 centimeters. The fact that the circle of confusion is considerably larger with the high-power objectives supports the writer's contentions.

Table IV

CIRCLE OF CONFUSION

Apple Green Light (A. U. 5269) — approximately 47,500 W.L. per inch

N. A. of Objective	Magnification on Focal Plane at 55 mm 6x Eyepiece	Circle of Confusion
1.32	1.160	0.00925
0.95	550	0.00609
0.65	270	0.00437
0.30	135	0.00474
0.25	125	0.00526
0.12	50	0.00439

KNOW YOUR MONEY*

The United States Secret Service, a division of the Treasury Department, is one of the oldest investigating agencies in the United States, having celebrated its Seventy-fifth Anniversary in 1939.

Its duties are, first, to protect the person of the President of the United States and the President elect. Second, the protection of all obligations of the Government from forgery, alteration, or counterfeiting. Third, a miscellaneous group of offenses dealing principally with attempted frauds against the government. Among these various offenses falls the protection of the currency and coinage of the nation from alteration and counterfeiting.

In 1938 counterfeiting activities were great. Chief Frank J. Wilson decided that inasmuch as the Service was charged not only with the arrest of violators of the counterfeiting laws, but also with the prevention of counterfeiting perhaps more should be done along preventative lines. Consequently, a widespread educational campaign was begun.

The first year of this campaign was spent principally in New York City. In 1940 equipped with a twenty-minute sound movie with Lowell Thomas as narrator, the Service has made this educational campaign nation wide. This film issues warnings against false negotiation of government checks, instructions on the detection of counterfeit coins, and deals principally with the detection of counterfeit currency.

The idea behind this educational campaign is that by making a study of good money the detection of counterfeit money will follow automatically, and that when counterfeit money can be detected auto-

* Released by the United States Secret Service, May 6, 1940.

matically the market of the counterfeiter will be destroyed. The principal stress, therefore, is laid on the genuine currency with the contrast to the inferior counterfeit money. Some of the points of information follow:

Types of Currency

The only three types of currency printed by the U. S. Government for circulation are:

1. Federal Reserve Notes, which bear *Green* serial numbers and seal.
2. United States Notes, which bear *Red* numbers and seal.
3. Silver Certificates, which bear *Blue* numbers and seal.

Portraits

Denominations of bills may be identified by portraits as follows:

Washington	on all	$1.00 bills
Jefferson	on all	2.00 bills
Lincoln	on all	5.00 bills
Hamilton	on all	10.00 bills
Jackson	on all	20.00 bills
Grant	on all	50.00 bills
Franklin	on all	100.00 bills

How to Detect Counterfeit Notes

1. Compare the suspected bill with a genuine of the same type and denomination. Observe carefully the following features:

(a) *Portrait*: Genuine is lifelike, stands out from oval background which is a fine screen of regular lines. Notice particularly the eyes. The counterfeit is dull, smudgy or unnaturally white; scratchy; background is dark with irregular and broken lines.

(b) *Seal* on genuine, sawtooth points around rim are identical and sharp. On counterfeit sawtooth points are usually different, uneven, broken off.

(c) *Serial Numbers*: Genuine distinctive style, firmly and evenly printed; same color as seal. Counterfeit, style different, poorly printed, badly spaced, uneven in appearance.

(d) *Paper*: Genuine bills are printed on distinctive paper containing very small red and blue silk threads.

2. Rubbing a bill will not prove whether it is genuine or counterfeit; ink will rub off of either.

How to Detect Counterfeit Coins

1. *Ring* all coins on a hard surface. Genuine coins sound clear and bell-like. Counterfeits sound dull.

2. *Feel* all coins; most counterfeit coins feel greasy.

3. *Compare* the reeding (the corrugated outer edge) of a suspected coin with one known to be genuine. The ridges on genuine coins are distinct and evenly spaced. On counterfeit coins they are poorly spaced and irregular.

4. *Cut* the edge of suspected coins. Most counterfeits are made of a soft metal which can be easily cut with a knife.

5. Test suspected silver coins with acid. Scrape the surface and apply a drop of acid. If bad, the coin will turn black unless it has a high silver content. Silver test acid solution may be purchased at any drug store.

Cashing Treasury Checks

In the case of WPA workers the various states issue identification cards with the worker's number, signature, and sometimes description. Any check with the address far removed from the place where presented should be cause for suspicion.

Conclusion

It is hoped that all of the citizenry of the United States will cooperate with the Secret Service in attempting to stamp out this ever present evil.

QUESTONNAIRES

The response to the War Department and B.P.A. questionnaires has been good, but it will take some time to tabulate the replies and get the material into the desired form for Washington and for our own files. Further information about the questionnaires will undoubtedly be given at the Convention.

PHOTOGRAPHING FRESH AUTOPSY MATERIAL IN COLOR WITH POLARIZED LIGHT

HANS FREIVOGEL, M.D. and CHARLES BREEDIS*

THE value of photographs taken at autopsy is well recognized. They serve not only as a record of spatial relations, but also, if taken in color, record hues that can not be duplicated by any known method of preservation. The more extensive use of photography in this field has been hindered by considerations of expense, time involved, bulkiness of equipment, and most troublesome of all, the difficulty of eliminating from photographs the glaring high-lights that are seen on the surface of fresh tissues exposed to air. We have found that the method to be described lessens these difficulties to such a marked extent that it has

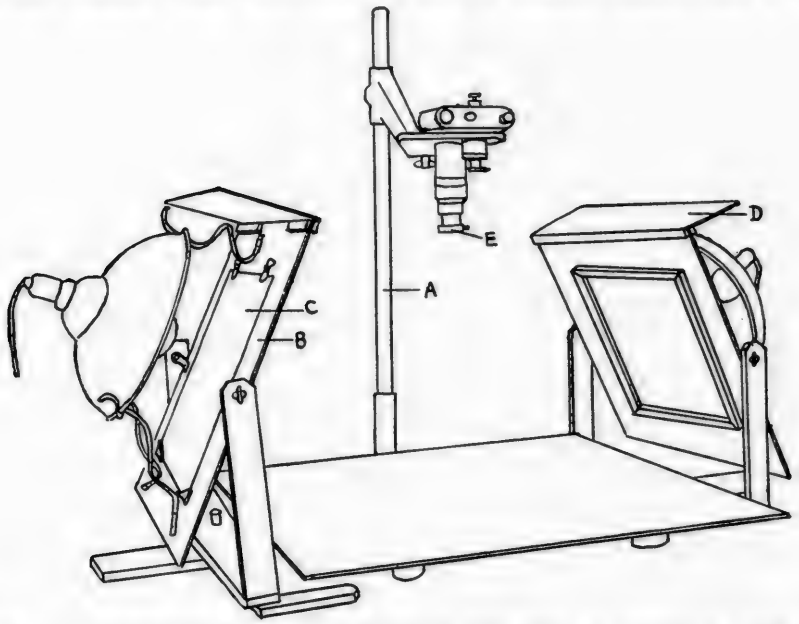


Figure 1. Arrangement for photographing specimens by means of polarized light.

become possible to take photographs routinely of all autopsies while they are in progress.

Two Leica Cameras are used, one loaded with Kodachrome "A" Film, the other with a fine-grain panchromatic film. These are used

* Received for publication February 5, 1940 from the laboratories of Flushing Hospital and St. John's Long Island City Hospital (Jacob Werne M.D., Director).

interchangeably on the Leica Rotating Focusing Attachment, figure 2. The latter is fastened either to the supporting arm which slides on the upright of the Focomat Enlarging Stand, to the ball-and-socket head of

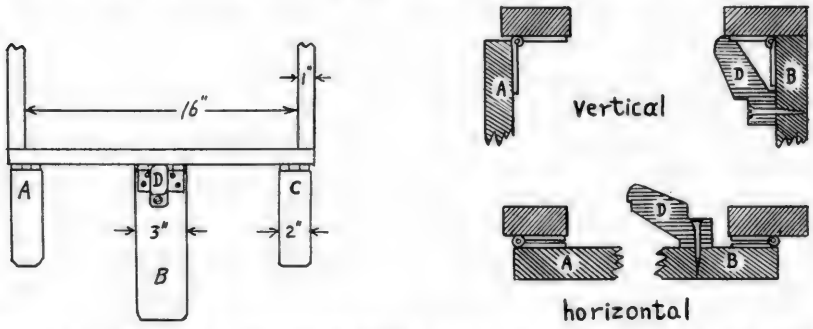


Figure 1A. Base of illuminating stand, showing method of folding legs for use in vertical or horizontal position.

a tripod or to the board of a special camera stand to be described later.

We find two lenses to be sufficient: the Elmar f. 3.5-50mm and the Hector f. 4.5-135mm. They are used in combination with a set of four extension tubes. The Elmar 50mm requires in addition an Intermediate Focusing Mount. This lens is useful when photographing large objects, the Hector 135mm when a small field is to be photographed. For critical focusing we use a 30 x magnifier, for rough focusing a 6 x magnifier. The Rotating Focusing Attachment has the advantage that the two lenses can be kept in it all times and either can be used at a moments notice.

The Focomat Enlarging Stand, figure 1A, is sufficient for photographing all specimens that have been removed from the body. For views of the whole body from a height or at various angles we have constructed a special stand consisting of a small platform that slides vertically on a 1½ inch galvanized iron pipe. This arrangement is shown in figure 2 and 2A. Since the platform can be rotated around the pipe and can be fastened in any position, it is possible to take photographs of both the autopsy and the removed specimens merely by swinging the platform around and raising or lowering it.

The speciments are photographed either on an evenly trans-illuminated opal glass plate, in the usual manner, or on a plate of black glass. Black is a more suitable background for most specimens and does not require as careful cleaning as the trans-illuminated white background. These considerations hold only if polarized light is used to photograph the specimen.

The method of illumination is shown in figure 1. Two No. 2 Photoflood bulbs in aluminum reflectors are fastened by means of brass

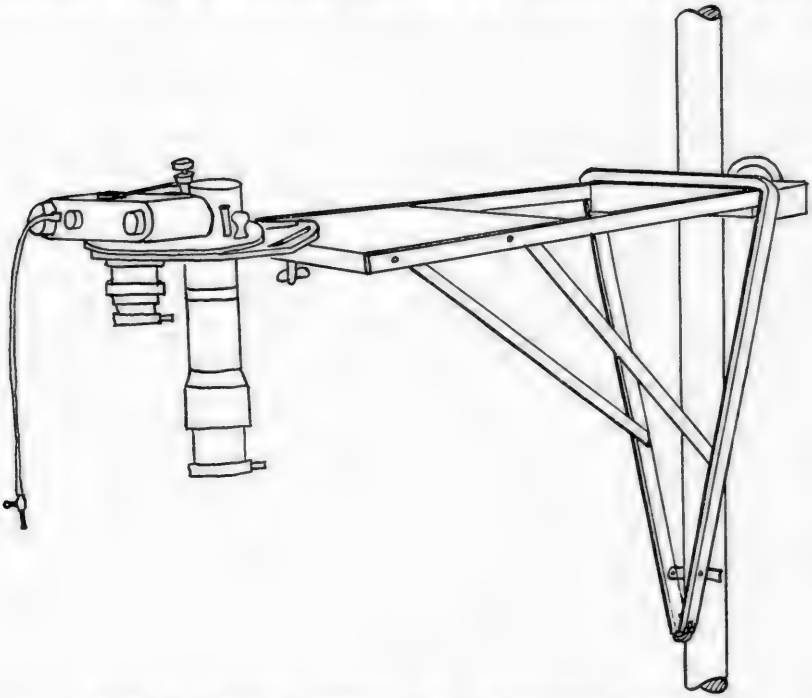


Figure 2. Camera platform for photographing autopsies.

strips to a light frame of ¼″ veneer board (B). Between each light and the specimen is a 12″ x 12″ sheet of Eastman Kodak Pola Screen

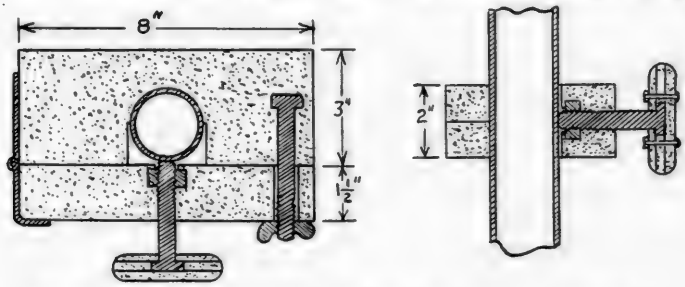


Figure 2A. Construction of lock for Camera platform.

(C), mounted between two glass plates and fastened in the opening of the frame with clips. It is important that only polarized light reaches the specimen. For this reason the Pola screens are fitted in a light-tight

manner to the frames. The portion of the frames facing the specimen is painted black in order to minimize the reflection of unpolarized light coming from the specimen. Scattered nonpolarized light from the lamp

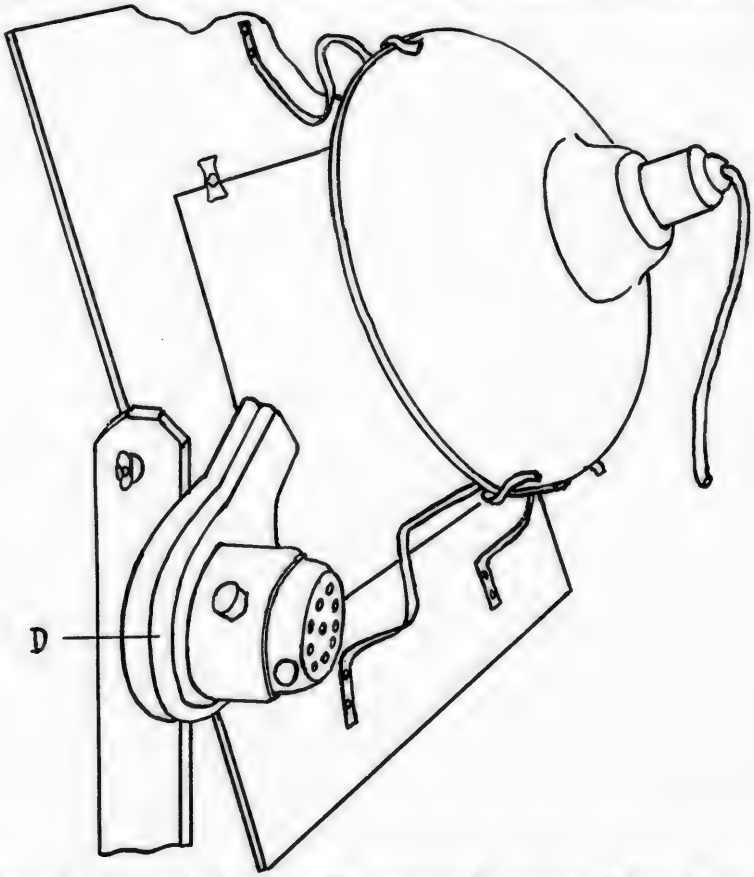


Figure 3. Method of cooling Pola screens by means of hair dryer (D).

is prevented from entering the lens by means of cardboard screens (D), placed on top of the supporting frames. A rotating Pola screen, Eastman Kodak Type I A, is placed in front of the lens (E). We use a separate Pola screen for each lens.

The large square Pola screens are already cut by the manufacturer so that the plan of polarization of the emitted light is parallel to two

Figure 4. Atrioventricular valve, its chordae tendinae and the papillary muscle. Ordinary illumination.

Figure 4A. Atrioventricular valve, its chordae tendinae and the papillary muscle. Pola screen was placed over the lens and rotated 90°.

4

4A

of the edges. When the screens are superimposed they correspond to either crossed or uncrossed Nicol prisms. After they have been superimposed in such a way that a maximum of light passes through them they are separated, still keeping the edges parallel, and mounted as shown in figure 1. When photographing the specimen illuminated by light polarized in this way, the rotating Pola screen in front of the lens is turned until all highlights disappear.

The frames are mounted in wooden supports so that they swing on a horizontal axis but can be fixed by means of thumb screws at the sides. The bottoms of the supports are adaptable for fixing them to the sides of the trans-illuminating box or for placing them in a self-supporting manner on any flat surface. In the former case the middle leg is fixed by means of a brace. In the latter the brace is turned so that the middle leg may be swung horizontally, figure 1A. Though we have found the wooden construction suitable for our work we think that if a light metal were used it would be more adaptable and less bulky.

Due to the fact that the large Pola screens deteriorate when exposed to the heat of Photoflood bulbs for a long time, it is advisable to do preliminary focusing with a strong unpolarized light. Mr. N. Grand of the St. Johns Hospital Laboratory has altered a standard foot switch so that it turns on the polarized light and turns off the strong unpolarized light with one movement. He has found that the stream of air from an electric hair dryer from which the heating element has been removed is very effective for cooling the screens, figure 3. This is also connected to the foot switch, in parallel with the Pola screen lights.

Due to the similarity of many pathological specimens it is important that accurate records be kept at the time the pictures are made. If numbers are included in at least a few pictures on a roll of film they form a permanent record for the entire roll, provided that each specimen is carefully described and numbered as it is photographed. To make the photographs readily available for use we keep an index card of each. Each card has a 5 x 8 cm. enlargement pasted on the front and the data pertaining to the picture is written on the front and back of the card.

In concluding we would like to stress the striking clarity that is obtainable in photographs made with properly polarized illumination, figure 4, as compared to ordinary illumination, figure 4a. This difference can best be demonstrated by observing the image on the ground glass as the Pola screen in front of the lens is rotated.

We are indebted to Dr. J. Werne for many valuable suggestions and criticisms.

CERTAIN ARCHIVAL CONSIDERATIONS CONCERNING PHOTOGRAPHIC RECORDS*

JOHN G. BRADLEY†

ALL archives and records belonging to the Government of the United States fall within the general scope of the National Archives Act and, on approval of the National Archives Council and at the request of the Government agency concerned, may be transferred to the National Archives Building on requisition of the Archivist.

This statement is, of course, subject to considerable qualification. It does not mean, for example, that all records will be transferred, nor does it stipulate what constitutes Government ownership. Neither does it define what is meant by such words as "archives" and "records." These are highly technical matters, a consideration of which may well be postponed for the present. At best the statement is submitted in an effort to establish the broad limits of eligible material within which we find the subject under discussion — photographic records.

As far as subject matter is concerned and everything being equal, photographic records are given the same consideration as paper records. But everything is not equal and it is when we consider the differences between the two types of records that we find our problems, the first of which may be said to be that of inadequate storage facilities. Let us see.

The volume of photographic records was revealed by the surveys instituted shortly after The National Archives was organized in the Fall of 1934. These surveys disclosed 903 tons of photographic material scattered among nearly 2,000 depositories throughout the country. In this category still pictures enjoyed the most universal use while microfilm and aerial maps represented the most rapid growth. A breakdown of this material as of September 1938 was as follows: motion picture film, 60 tons; x-ray film, 200 tons; aerial and cut film and still picture negatives, 400 tons; glass plates, 140 tons; and aerial rolls, 104 tons. Of the total amount surveyed more than 70 per cent was found to be of the nitrocellulose or flammable base and more than 50 per cent of the depositories were found to represent poor storage conditions.

It is probable that the volume of this material will continue to increase not only as old uses of film are applied to new fields but as new uses are discovered. Prompted by a desire to conserve space, many agencies of the Government are making use of microfilming on a large

* Read before the Biological Photographic Association at the Mellon Institute, Pittsburgh, Pennsylvania, September 15, 1939.

† National Archives, Washington, D.C.

scale. Already the number of items that have been so photographed run into the hundreds of millions. It is probable also that aerial mapping will continue until every square mile of the United States has been photographed and re-photographed. During the last World War the volume of motion pictures increased materially and it is expected that the present European conflict will result in a definite increase in the volume of motion pictures taken on a documentary or factual basis.

Recognizing the trend in the increased use of photographic records, our next consideration was given to existing storage facilities, which at best were inadequate. The matter was referred to the Federal Fire Council which is taking definite steps to contribute to a solution of the problem. In a report by a sub-committee of that organization, approved March 30, 1938, we find the following extracts.

> Comparing the tabulations with conditions as revealed by previous surveys there has been a notable improvement in storage conditions particularly for motion-picture film. Many very bad storage places have been greatly improved and many small collections of still negatives have been moved to better storage places. On the other hand there is still much to be accomplished in the education of those in charge of still and aerial negatives and in the promotion of increased use of non-flammable stock. There is also much to be desired in improving conditions of storage for flammable film **** Even the acetate or safety film which is about equal to paper in combustibility, when heated in closed receptacles also decomposes and gives off noxious and irritating gases.
>
> Summarizing this report the following recapitulations and conclusions are submitted:
>
> 1. There is a large amount of film in Federal custody which is definitely increasing — rapidly in certain fields of endeavor such as aerial mapping.
>
> 2. It is entirely possible and practical to store and handle flammable film safely as many Government agencies are now doing.
>
> 3. Other Government agencies, however, have depositories which represent distinct fire hazards, constituting a serious threat not only to the record material itself, but to surrounding property and human life.
>
> 4. Many of these hazardous conditions are the result of limitations placed on the agencies through no fault of their own but which are none the less serious. Basic corrections in such instances can be made only by the provision of funds needed for the construction of new storage facilities.
>
> 5. In other instances, many improvements can be made within the agency concerned without a great deal of difficulty by the observance of accepted practice.
>
> 6. The hazards do not seem to be universally recognized by those concerned, but a willingness to help and be helped was plainly evident.

The Committee wishes to submit the following recommendations:

1. That all Government agencies handling photographic film be furnished with a copy of this report.
2. That the handling of nitrocellulose film be limited, whenever possible, to trained personnel, familiar with the hazards involved.
3. That safety stock be substituted for nitrocellulose stock whenever possible or practicable.
4. That in the absence of other information, the regulations of the National Board of Fire Underwriters and of the District of Columbia be followed.
5. That all surplus and non-active film be disposed of through established channels.
6. That the construction of a central storage building be encouraged not only for non-active material which may be worth preserving, but for active and semi-active material used by agencies lacking adequate storage facilities of their own.

The foregoing represents a general statement of the storage problem confronting us. It is hoped that adequate storage space and facilities will be provided before serious losses are suffered; and, let it be said in passing, that this hope is not without foundation. In the meantime we have undertaken to use what space we have to the best advantage both in terms of necessity and as a foundation for efficient use of additional space when it shall have been provided. These efforts have been divided into two general fields: (1) the storage of film in terms of fire hazards in which the Federal Fire Council was principally interested and (2) the storage of film in terms of chemical preservation.

The first product of our efforts in the matter of storage was the installation of stainless steel cabinets wherein the principle of unit isolation was observed. For the storage of motion-picture film, these cabinets were designed with a separate compartment for each reel or for approximately each five pounds of film, so insulated that a fire originating in one compartment would not spread to another. Furthermore each such compartment was vented to a common vertical flue leading to the exterior of the building. The venting to the exterior served to prevent a building up of gas pressure that would create explosive conditions and to protect the worker from exposure to noxious and poisonous gases. This type of cabinet is discussed in detail in the Journal of the Society of Motion Picture Engineers.[1]

The second product of our efforts was a non-insulated or a semi-insulated cabinet which is discussed briefly on page 311 of the Journal

of the Society of Motion Picture Engineers, Volume XXX, Number 3, 1938. Briefly, however, the principle of unit isolation is observed and the same venting is provided in this cabinet as provided in the insulated cabinet. Instead, however, of depending on insulation to prevent a spread of fire, the dependence is placed on a cooling agent — preferably water. Such construction provides a much more economical unit than that represented by insulation and should enjoy, therefore, more universal use. The results of some sixty-eight burning tests, most of which were conducted at the National Bureau of Standards, indicate that this cabinet is entirely adequate both for fires originating inside the cabinet as well as for fires originating outside the cabinet such as those represented by a burning building.

Our next problem was that of storage in terms of chemical deterioration. It is a well known fact, based largely on experience, that the life expectancy of a film, particularly of a nitrocellulose film, is comparatively short. Some of our most valuable collections have suffered severe losses in about twenty years and still other losses have been sustained within much shorter periods. It is hoped that when the photographic characteristics of acetate film have been improved, its use will be much more universal. However, since some 73 per cent of the film in federal custody is on the nitrate stock, we have had to plan our storage in terms of maximum hazards.

Our study of this problem was a joint original research project under the auspices of the National Research Council with funds provided by The National Archives, the Carnegie Foundation, and others. The actual work was done principally at the National Bureau of Standards and a summary report on this project has been published.[2] Briefly, however, the following represent some of the tests used in determining the stability of both the acetate and nitrate film: Folding Endurance, Loss of Weight, Viscosity, pH Determination, and Copper Number. In all such tests the acetate film appeared to be far more stable than the nitrate film. As a result of these experiments it is believed that if the film is carefully processed and the residual hypo removed, if it is stored in a building where air conditioning is used, and finally, if accepted

[1] Report of the Committee on Preservation of Film, Journal of the Society of Motion Picture Engineers, Vol. XXVI, No. 6, 1936, pp. 653-660 and Vol. XXVII, No. 2, 1936 pp. 147-154.

[2] Summary Report of Research at the National Bureau of Standards on the Stability and Preservation of Records on Photographic Film by B. W. Scribner. National Bureau of Standards Miscellaneous Publication M162, U. S. Printing Office.

principles of good housekeeping are observed, nitrate film should last fifty years or more before it has to be duplicated, and that acetate film will last considerably longer — perhaps two or three hundred years. This, of course, makes no accounting for losses through wear and tear. It might be said in passing that other materials are being studied, some of which hold out considerable promise; one of these is Osaphane which has a light-sensitive dye incorporated in its base to form the image.

Our next general consideration is that of subject matter. Having this volume of material to consider, what should The National Archives undertake to perpetuate for the benefit of future generations? The problem in this respect is further emphasized by the fact that Section 7 of The National Archives Act provides a non-governmental source of material in this language: "The National Archives may also accept, store, and preserve motion-picture films and sound recordings pertaining to and illustrative of historical activities of the United States." It was stated a moment ago that as far as subject matter is concerned and everything being equal, photographic records are given the same consideration as paper records. It appears, therefore, that a gift source of material provides one of the inequalities that contribute to our problem. And since other forms of photographic records may not be accessioned from gift sources it would seem that brevity and unity can be preserved without serious loss by limiting the remainder of this discussion to motion pictures.

What is a motion picture? This question may be answered in two ways. For example we say that a motion picture is an optical illusion, resulting from persistence of vision on the retina of the eye. That, however, is only a part of the answer. In terms of subject matter the answer is more involved. Its spiritual, sociological, and political aspects must be considered. Here is a new force, a new member of society who slaps us all on the back with self assurance. Perhaps the question could be better stated as "WHY are motion pictures?"

In the first place our subject matter is a nebulous thing that lies somewhere in the borderland of fact and fancy. It is a compound of light and shadows; of sound, mechanics, and electricity; of painting and architecture; of drama and pantomime; all this and more, mixed with the hard and soft facts of life. In brief, it is the magic of motion pictures and recorded sound.

Within the four decades that mark the era of modern motion pictures, the industry has emerged from the penny arcade, the peep show, and the nickelodeon to the present spectacle of feature pictures, the newsreel, and the expository film; and an average of nearly 90,000,000 ad-

missions are counted at the movie houses up and down our streets every week of the year.

Here is a major social force which is methodically and certainly leveling our habits and effectively going forward in its process of mind-making. Not only do American-made motion pictures affect our lives, but the lives of millions of others throughout the world where they hear our language spoken and see our customs practiced. Here is a bloodless conquest of empires that Napoleon never dreamed of.

Now, what is the essence of this force? What is its magic? Some say it is an opiate that dulls our wits and drugs our ambitions, or a retreat for day-dreaming in our flight from reality. Others say it is a stimulant that spurs us on to new ambitions, a leaven of greater understanding, and a new art that speaks a universal language for millions of emotionally undernourished people. There is truth and exaggeration mixed with snobbery in all of this. But let us look into the matter a little more closely. What is the basis of our interest in motion pictures? Why are we interested in anything?

The answers to these questions cannot be given in a nutshell but can be illustrated. Many things contribute to the phenomenon of interest; novelty, surprise, movement, harmony, color, and so forth. Display of energy is another factor. Thus some people go to a football game who know nothing of the game. Nearly all of us will watch a great locomotive pass without knowing much about trains, for the simple reason that there is mass in motion and a display of energy. Still others will go to a football game or any game because they know the rules. In this case the interest is based on subjective imitation. *They,* as onlookers, are out there running interference. *They* are knocking the home-run. It is *their* ace the partner trumps. *They* know the bonuses and penalties and hold their breath on the possibilities of a misplay.

In motion pictures, particularly in the story telling variety, we have an imitation of life and in a common tongue. This time we all know the rules. *We* share the heart-aches of the misunderstood. *We* punish the villain. *We* enjoy the luxury of the rich or share the poverty of the poor. It is *our* man that is on trial. It is *our* little Nell they have done wrong. We run, dance, sing, laugh, weep, pray, and agonize with the make-believe shadow people who exist only in two dimensions but with whom we identify our own lives in a most powerful reality for a fleeting moment.

There is another factor of interest which transcends imitation and becomes a reality. I refer to the age-old fight against gravity and the struggle for self-expression. Let us see.

In the beginning man was earth-bound, wading in mud. His movements were slow and ponderous. He knew little of the world around him in a day's journey away. For the most part he lived his span of years and died in the same community where he was born, indigenous to his own soil.

Yet his lot did not prevent him from dreaming. On the wings of his imagination he travelled with the wind and the sun. He visited the mountains and the valleys of the earth, the rivers and deserts of the earth, and the seven seas.

And his dreams made him restless.

Then one day, a day made up of many centuries, his dreams came true. Today he no longer wades in mud; he is no longer earth-bound, but has overcome gravity and conquered space. First he walked, then ran, but now he can fly.

Again, in the beginning man was inarticulate. He could neither speak effectually nor be understood. He had emotions but few words with which to express them. When his feelings piled up inside him, and having no adequate vent for expression, he turned to intemperance of one kind or another or suffered in silence. The gates of his speech were bolted both on the inside and on the outside. A few simple imitative words, a grunt or a growl, grimaces and pantomime were his only stock in trade. These were poor instruments of expression for a creature born in the image of God.

And his emotions made him restless.

Then one day, a day made up of many centuries, man became vocal. With the few words he had accumulated he started thinking, and then created more words with which to do more thinking. He invented the alphabet, writing, and the printing press, and his vocabulary grew by leaps and bounds. But words did not satisfy man's urge for self-expression. He employed painting in colors, sculpture in mass, and music with its hundred moods. Then photography, and finally motion pictures with recorded sound made their appearances. Today man can speak and be understood. His tongue has been freed from its prison.

Let us see now how the illustration fits. Granted that man has learned to fly, some of us cannot afford a pair of wings. Here is where the alchemy of motion pictures comes in. In the spirit of make-believe let us think of motion pictures, especially the newsreel and the travelog, as a magic carpet which all may ride, rich and poor, and from which we may view the glories of the earth; great mountain peaks pointing their fingers up through the clouds; rivers whose names conjure up mystery, serene or violent, as their whims dictate; cities and towns up and down

whose streets life elbows its way; and the people of the earth, whose acts are "divided into seven ages."

Yes, man has learned to travel with a new speed; the mountain has come to Mohammed. And man has learned to speak with a new power. Not every one of us as yet has a camera nor are we all able to master its technic. Individually, therefore, we cannot enjoy its full expression. But composite man has mastered the new eloquence. *His* tongue has been touched with — shall we say — apostolic fire. His god-like voice booms and a hundred million pause and listen.

Thus out of the dim past man has struggled against the inertia of his heritage, but, motivated by his dreams, has attained mobility, articulacy, and, should we not add, a form of immortality. For example, when those who follow, see us on the screen and hear our voices, they will not think of us as dead, but immortal through the instrument of this new magic. Granting the importance of motion pictures and confronted with this inexhaustible source of supply the next question that confronts us is that of selection. In other words what material or what classes of such material shall be admitted to The National Archives?

In the first place, although we know that this potential supply exists we do not know exactly what it consists of. For example, the motion-picture industry, although relatively very young, has become one of our major industries. During this rapid growth, stimulated by diverse and scattered interests, no mechanism was provided which would adequately record this growth or even list the subjects covered. It appears, therefore, that as far as past productions are concerned, we are working pretty much in the dark.

Although we have no adequate listing of the motion pictures that have been produced, we do know that the scope of this medium is being rapidly expanded and for the most part quite worthily. It has transcended the purely entertainment field in which it enjoyed its early success and is now exploring subjects of primary interest to the scholar in general and to the historian in particular. For example, following closely on the heels of the entertainment picture came the informative newsreel. Following the newsreel and still in the growing pains are the factual—expository and the propaganda pictures used as instruments of teaching and persuasion. Although the newsreel is basically factual, its primary purpose is to record and portray *news* — the sensational part of current events. At best it is a hit-and-run vehicle and makes little attempt to explore objectively the many sides of a given subject. Its chief value lies in the raw material it may furnish for future compilations. The factual-expository picture (sometimes referred to as docu-

mentary film) is just taking on form and definition. To what new realms it will lead us no one can prophesy with any great accuracy. We do know, however, that in its present form it transcends the newsreel in its fact-finding policy and its story-telling quality, and that it is gradually meeting the demands of scholarship. A typical example of this type of picture is THE RIVER, produced by the Farm Security Administration under the direction of Pare Lorentz.

But this is only the beginning. There are many new frontiers which this type of picture is exploring and many others which it will explore in the future in its efforts to serve science and education. For example, there are excellent pictures being taken of certain phenomena of the sun, through the telescope. Others are being taken through the microscope which cover subject matter not visible to the naked eye, such as bacteria, chemical reaction, crystalization of metals, et cetera. Then, through the instrumentality of electronics, there are sound recordings being taken on both film and on disc material which might be called microphonographic records not audible to the human ear such as the friction of machinery, the noise of insects, heart beats, and functional sounds of various kinds. Finally there is the propaganda film which may mix truth with falsehood, and sense with nonsense, with immeasurable results. In general it seems that this new medium is laying the foundation for a new renaissance and that its potentialities for service are almost unlimited. What place in history these pioneer products, the incunabula of the motion picture industry, will occupy, it would be difficult to predict at this time.

This discussion may have over-emphasized our problems. In part such emphasis was intended. The scope and magnitude of this field could not be adequately outlined otherwise for the reason that many of our problems are still unsolved. However, out of this chaos of opportunity we are finding our way and are making definite progress. For example, we have accessioned over[3] 1,500,000 feet of historical motion-picture film some of which is priceless. We have been the beneficiaries of much good will both from governmental and private sources so that the prospects of additional material are most promising, perhaps in greater quantity than we will be able to accept. It is hoped that our friends will continue their sympathetic cooperation and that many new friends will be added as we continue our exploration in this amazing new field.

[3] As of May 1, 1940 there had been more than 4,000,000 feet of motion picture film transferred to the custody of the Archivist.

PHOTOGRAPHY IN A MODERN MUSEUM

CHARLES SIMMONS AND MURIEL KELLEY*

WHEN a visitor enters a museum he is confronted on all sides by work done photographically. This is especially true of a modern museum. New and interesting cases are constantly being installed and supplementary transparencies and photographs play a vital part in telling the story which the exhibits in a museum present to the public.

A museum as an institution has a variety of valuable information which must be placed where it can be used to advantage. Slides, transparencies, prints and enlargements are a small portion of the work done in the photographic department to aid in this program.

We have on file approximately 85,000 negatives. These include individual shots of each case or exhibit, plus a general collection of negatives pertaining to the museum proper. In addition we have large collections covering such subjects as nature photography, photomicrography, archeology, astronomy, New York State, State Parks, landscapes, public buildings, cities, art maps, travel and historical. These negatives form the basis for a permanent record of specimens and also show the progressive development of museum display cases and their contents.

Most of the transparencies used in this Museum are 8″ x 10″ and are made in the Eastman projection enlarger. These transparencies are photographic labels, either pictorial or literary, which give additional information concerning the exhibit. First — It has been found that transparencies and photographs hold the interest when the original objects do not. Second — In some cases transparencies of a complete object make an original fragment intelligible. Third — In many instances they divert the attention back to the original.

The slide department, which is one of the most important departments in the museum, would not be in existence were it not for the photographic department. There are approximately 80,000 slides, most of which were made in this department and include sets on nature and wild life subjects, travel, industry, agriculture, etc., also a large number of sets for juveniles which are used in classrooms of public and parochial schools. These slides are also borrowed by colleges, clubs, organizations of all kinds, and churches. Besides the making of new slides there is a constant demand for replacements. Breakage is quite frequent when they are in circulation, necessitating the constant repair to keep these sets

* Received for publication January 8, 1940 from Buffalo Museum of Science, Buffalo, N. Y.

in first class condition. In conjunction with the slide department, there is also the Picture Lending Library. This collection is made up mostly of 8 x 10 enlargements on 11 x 14 mounts. There are made into five sets of each subject and are used as bulletin board displays in the schools.

This museum carries its influence not only to the citizens of this locality, but to all parts of the world. By publication and illustrations it places authoritive and critical description of typical collections and subject matter in the hands of all who can use them. Each year hundreds of requests come from all parts of the world for enlargements showing the various phases of museum work. The most popular subjects are for photographs showing the progress of group displays being made, museum technic, cases and exhibits. Those engaged in museum work, fairs and exhibitions, scientific, educational, and research activities are constantly requesting photographs to aid in these various fields. Next in demand are photographs of activities showing junior and adult groups, organizations, classes, clubs, etc., as encouraged by museum influence. Nature and wild life subjects are used to illustrate a large number of magazine articles.

In the value of exchange, photographic work affords protection against loss or damage of specimens, and the comparative cost between mailing a photograph and shipping the actual specimen is an item given careful consideration especially if an institution is hampered financially. Where there are sufficient funds available to the photographic department of a museum, photographs are produced at cost serving as a study aid to school children. On an original photograph of materials that are extremely perishable the museum itself reaps publicity by loan of said photograph. Perhaps it would not be amiss to discuss some of the problems which confront a museum photographer. In 1932, it was found necessary to install a chart of geological history on the wall of the Hall of Geology. It was to be 12 feet long and 10 feet wide and there was not a great deal of time in which to do it. If the artist had to stop and measure each step in order to get the drawings and diagrams in exact proportions it would have taken far too long. So a simpler method was devised. A so-called thumb nail sketch was made by the artist and then turned over to the photographer. This sketch was photographed on a 4 x 5 commercial film and then made into a steroptican lantern slide and then projected onto the wall so that the image was in exact proportions to the specifications required. From this it was comparatively simple for the artist to trace in the outline. (Figure 1. Chart Geological History.)

This same process was also used for the murals in the Hall of Primitive Races.

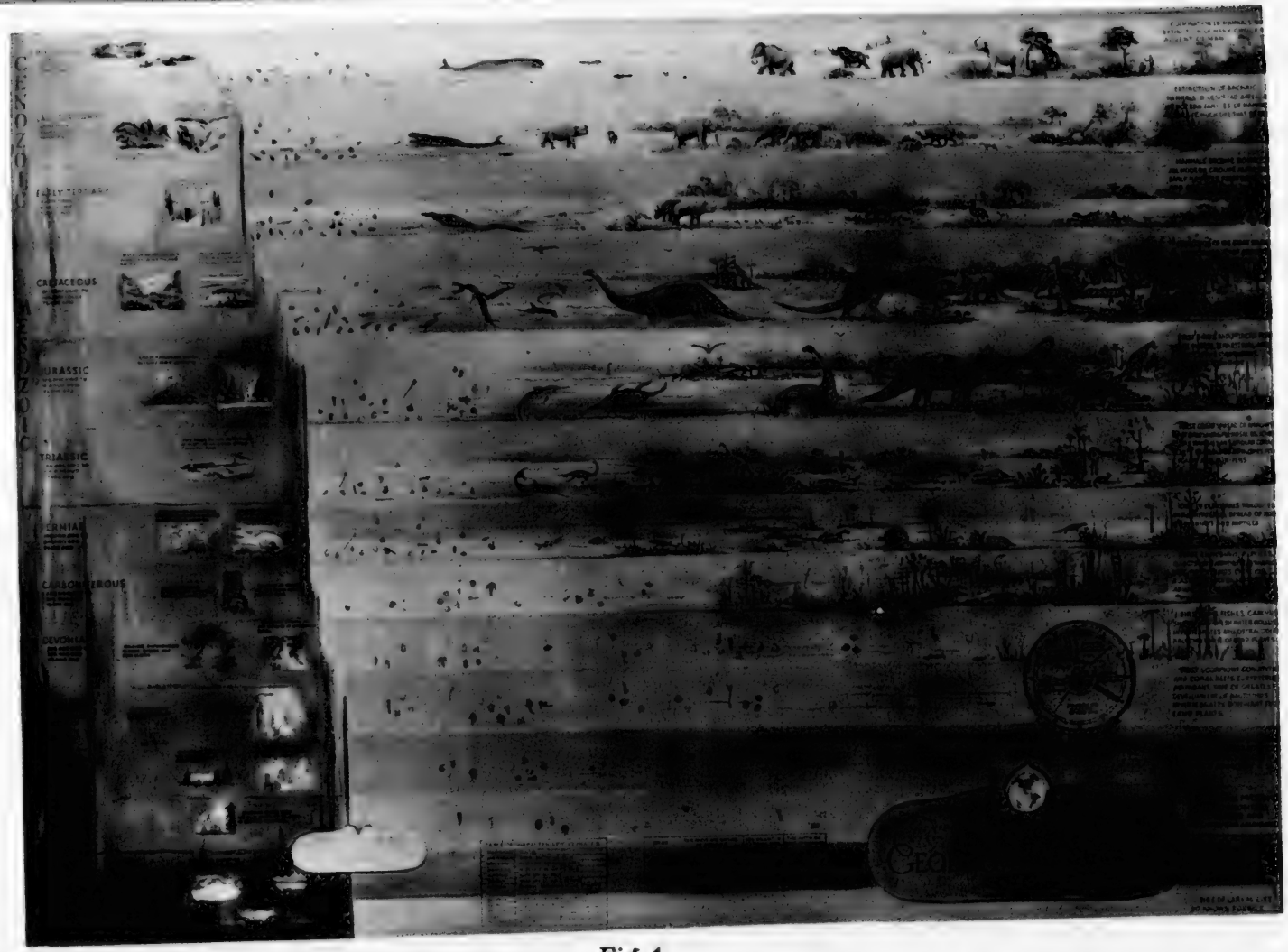
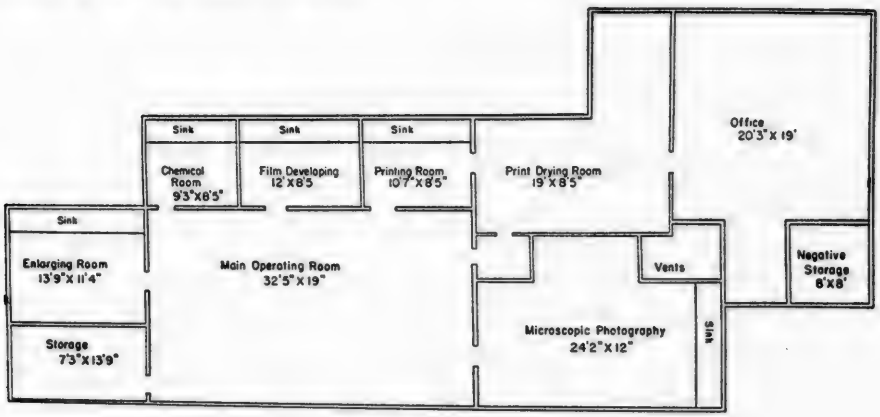


Fig. 1

UNIV. OF MICH.

The geological time clock, the mechanism of which ticks away countless eras of the earth's history has fascinated throngs at the Museum with its pictorial vividness. On the outer portion of the face of the clock the large hand points out the stages of the earth's history illustrated on the central screen, while the ticks of the small hand each represent the passing of ten million years from the Azoic to the Cenzoic eras. On the central screen are flashed a series of illustrations. This is done with the slides inserted in a Balopticon lantern. The slides are really two slides in one. In place of cover glass another slide plate was used so that two are placed emulsion side together. When this is projected onto the screen from behind the clock the picture and title underneath it are in correct register.



PHOTOGRAPHIC DEPARTMENT
BUFFALO MUSEUM OF SCIENCE — BUFFALO N.Y

FIGURE 2

Another problem which often confronts the museum photographer is photographing large objects such as statues, large animals. Often they weigh tons and of course cannot be moved. Naturally they are placed where they will show to best advantages, but far too often, to photograph from that same view point will result in distortion that will look far different from the original. We have found that daylight is the answer in many cases as incandescent light will result in conflicting shadows. This of course does make prolonged exposure necessary, but fortunately, most objects we photograph that are large, do not move.

A vertical camera which was made in the shop of the museum, is an 8 x 10 which also has a 5 x 7 as well as a 4 x 5 back. It is suspended from a side wall and is lowered and raised by aid of a hoist. The sup-

porting arm which heads the camera was made from ¾ inch pipe.

Figure 2 shows a floor plan of the department. We are located in the basement of the building where 2215 square feet are devoted to photography.

In conclusion it might be said that the photographic department of a museum is one of its most vital centers. Without this department, there would be no accurate record for filing purposes, no slide department no picture lending library, and no illustrations for publications and nothing to supplement the display contents. Thus a photographic department in a museum not only pays for itself, but is essential in order to harness the museum resources, activities and illustrations, which are to be displayed to best advantage.

In the mounting of prints I have often been annoyed by the bother of calculating proper margins to get them equidistant at the top and sides. Some time ago, I calculated the margins required for two commonly used mounting stock sizes. A compositor friend set it up in type and pulled some proofs for me. I will be glad to mail one proof on request to any reader who might find this chart of some help.

N. S. HORTON
Shaughnessy Bldg.
Montreal, Canada

Width of Print	MARGIN	
	15 x 20	16 x 20
7¼	3⅞	4⅜
7½	3¾	4¼
7¾	3⅝	4⅛
8	3½	4
8¼	3⅜	3⅞
8½	3¼	3¾
8¾	3⅛	3⅝
9	3	3½
9¼	2⅞	3⅜
9½	2¾	3¼
9¾	2⅝	3⅛
10	2½	3
10¼	2⅜	2⅞
10½	2¼	2¾
10¾	2⅛	2⅝
11	2	2½
11¼	1⅞	2⅜
11½	1¾	2¼
11¾	1⅝	2⅛
12	1½	2
12¼	1⅜	1⅞
12½	1¼	1¾
12¾	1⅛	1⅝
13	1	1½
13¼	⅞	1⅜
13½	¾	1¼
13¾	⅝	1⅛
14	½	1
14¼	⅜	⅞
14½	¼	¾

CHATS WITH THE EDITOR

Milwaukee, Wisconsin
May 10, 1940.

Mr. Leo Massopust, Editor
Journal of the Biological Photographic Association,
561 North Fifteenth Street,
Milwaukee, Wisconsin.

Dear Sir:

When I learned today that the Biological Photographic Association is going to hold its annual convention here in the country's Gemuetlichkeit capitol this summer, I couldn't refrain from writing to suggest that you invite the members to spend their vacations in Wisconsin this summer as part of their Milwaukee Convention trip.

I am certain that everyone, and particularly the fishermen and nature lovers, will enjoy the beauty of Wisconsin's great Northwoods. There the bright sunshine and clear fresh air will change their "darkroom pallor" into a coat of tan that won't come off; and they can leave all their troubles behind them when they enter the land of the great pines and whispering birches. Tell the fishermen to bring their deep-sea tackle if they expect to carry home any of the fighting beauties that fill the thousands of lakes formed in Wisconsin by the water which collected in the hoofprints of Paul Bunyan's Big Blue Ox "Babe." Remind them that the Wisconsin Conservation Commission plants more fish than any other state in the union, and that only last year the largest muskie ever caught was taken in one of our northern lakes. It is said that this finny giant gave himself up voluntarily when he found that he had outgrown the lake that had so long been his home! If any fishermen can't make up their minds between fishing the lakes for muskie, bass, pike, pickerel, etc., or the streams for brook and rainbow trout, tell them there are a lot of places where the lakes and streams are so close together that a fellow with an ordinary reach can cast in the lake with one hand and whip a stream with the other!

If a person grows tired of hauling out fish, he can always vary the program by stepping into a canoe and setting off on a tour of miles of

quiet streams and intercommunicating lakes where only herons, eagles, beavers, and ducks make their homes; or he can follow old forest trails leading deep into the haunts of the deer and black bear. If he likes to sail, there is sailing; and motor-boating; and swimming in water pure enough to drink; and golfing on courses where the beauty of the scenery makes concentration on the game difficult; and dancing in the evening; and cool drives over the smoothest and best-marked highways ever seen; and everywhere the peace and quiet that exist only in the Great Woods! After a vacation in Wisconsin, probably the only way to lure your members back to work would be with the temptation of a convention here in Milwaukee, famed for its good-fellowship, its good food and drink, and its knowledge of how to get the most out of life!

There's just one more thing, and that is to warn your members against the malicious rumor being circulated by partisans of other states to the effect that several submarines have been seen in Wisconsin lakes this spring. The "submarines" alluded to are actually only several medium-size Wisconsin muskies that I have had my eye on for several years. I'll be up there after them this summer, and I hope that many of your members will join in the pursuit. Just tell them to bring their own depth charges and strongest tackle.

Very sincerely yours,

EDGAR M. END, M.D.

NOMINATING COMMITTEE FOR 1940 ELECTIONS

The following members have been appointed by Mr. Schmidt to serve on the 1940 Nominating Committee:

MR. WILLIAM MARTINSEN, *Chairman,* Municipal Tuberculosis Sanitarium, Chicago, Ill.

MR. CARL D. CLARKE, School of Medicine, University of Maryland, Baltimore, Md.

MR. WILBOUR CHACE LOWN, Massachusetts General Hospital, Boston, Mass.

Elections will take place at the Milwaukee Convention. If you are interested in the outcome of these elections, or have a candidate to offer, get in touch with this committee. Nominations will also be accepted from the floor.

CURRENT PHOTOGRAPHIC ABSTRACTS

Undersea Cinematography. E. R. F. Johnson. *J. Soc. Mot. Pict. Eng.*, **32**:3-17, January, 1939. The equipment and problems of undersea photography with submergible cameras, lights, etc., are considered in regard to both natural settings and studio tank work. The optical properties of water are described, with particular reference to the selective absorptions and scattering of light in water, and the way in which filters help to overcome these effects. Scattering or haze is shown to be due largely to plane-polarized light and can therefore be effectively reduced by the use of polarizing plates. Illustrations include photographs of both motion picture and still cameras and equipment. J. G. S.

06-09

Cinematography in the Human Body. H. Grau. *Brit, J. Phot.*, **85**:101, February 18, 1938. An apparatus for taking motion picture films of the interior of the chest comprises a thorascopic tube at the top with a tiny electric lamp which illuminates the spot in question. An image of this point is focused in a lateral observing eyepiece which is directly connected to the motion picture camera. T. M. L.

Fish Portraits. H. Bade, *Camera* (*Phila.*), **59**:22, 24-5, July, 1939. The principal cause of failure in photographing fish lies in the aquarium itself. The great depth destroys detail, and the front surface of the glass gives undesired room reflections. Also, the fish moves so rapidly that the motion is difficult to stop without producing excessive light and the resultant heat. The author describes a narrow tank which is said to eliminate all of these objectionable features. It is suggested that ground-glass focusing cameras be used wherever possible. H .A. K.

Versatility added by Eastman Combination. *Amer. Cinematographer*, **20**:274, June, 1939. Beginning with a single adapter ring and a filter-retaining ring, the camera user can build up, step by step, a coupled series of such attachments as filters, Polascreens, and lens hoods. C. L. K.

K/44

Copying Color Transparencies: A Reader's Experiences. L. E. Hayward. *Miniature Camera Mag.*, **3**:553, May, 1939. A correspondent gives practical details of his set-up for making tricolor sets of negatives from Kodachrome transparencies. A. M.

097

Application of Photography to Gross Pathology. L. A. Waters. *Photo Technique*, **1**:22-7, August, 1939. The technique of photographing pathological specimens is described. Indirect or reflected light is to be preferred. A "background box" is used to produce a white background. If a dark background is preferred, the glass stage is covered with black velvet. C. J. K.

Selected by permission of the Eastman Kodak Company from the Monthly Abstract Bulletin of the Kodak Research Laboratories.

PHOTOGRAPHIC TECHNIC

F. R. HARDING*

Photographing Colored Drawings With Kodachrome Film

WHEN colored drawings are photographed on Kodachrome, the success or failure of the operation depends upon accurate computation of the exposure. If the exposure errs more than the equivalent of one half a stop either side of the correct stop, the result will be a failure.

The writer has had reasonably consistent results with the following technic: A Weston Meter is always employed. Kodachrome Professional Type B Film is used. Best results have been obtained by employing a film speed of 4 and taking a reading from the C or 2X point. Most drawings have been photographed from a distance which is equal to less than eight times the focal length of the lens employed. This means that the indicated stop, or f:5 number to which the lens is set, and the effective stop, or f:6 which actually applies, are not the same. Herein lies the reason why many Kodachromes of drawings and small objects have not been properly exposed. In the instruction booklet supplied with the Weston Meter is a table and directions for using it which will give the correct effective stop or aperture from which to compute the correct exposure. The Eastman Kodak Company publishes a circular slide rule, called "Effective Lens Aperture Kodaguide" which is very simple to operate and requires no computation. The correct effective aperture or stop shows as a direct reading after one dial is set. The cost is very moderate. To show how simple and yet necessary this matter is, an example follows:

Using a lens with a focal length of 10 inches, the camera is focussed on a colored drawing on a book page. After focussing is complete, if employing the Eastman table, the distance from lens to film is measured. Suppose this distance to be twenty inches. Rotate the dial until the figure 20 on the movable dial is below figure 10 on the focal length list. At the bottom of the movable dial is an opening in which is shown the magnification and exposure factor. Below this is the indicated aperture, and directly below this is the effective aperture. Suppose that the lens is set to f:16 (the "indicated aperture"). Below f:16 is f:32 (the "effective aperture"). Keep the lens set at f:16 and figure the exposure at f:32 on the meter. If this is done, correct exposure will result.

White backgrounds in Kodachrome usually show as very pale tan,

*Received for publication May 13, 1940. Children's Hospital, Boston, Mass.

but most or all of this is absorbed by the yellow incandescent projection lamp, so that on the screen the background appears white.

If the Weston Meter Table is employed, the final result will be the same, but the procedure will be different. In this case the distance from lens to subject is measured and the effective aperture is computed from the table.

It has been found that either an automatic exposure by accurate shutter, or a time exposure of over four seconds produces the most accurate result. A little thought will show why this is so. If an automatic shutter exposure is used, it may be necessary to try several indicated apertures in order to find an effective aperture that will correspond to some automatic exposure listed on the shutter.

The methods that have been described for finding correct Kodachrome exposures when copying colored drawings can be used for exposure computation when any small objects are photographed on Kodachrome.

News From the Trade

Bell & Howell of Chicago announce the following new accessories:

The new, 3-inch F2 Incre-Lite Projection Lens transmits a full 32% more light than its predecessor, and approaches very closely the speed of the brilliant 2-inch F1.6 lens which is standard on most FILMO 16 mm. projectors. The 3-inch lens will show the same size picture at a distance of 48-feet that the standard 2-inch lens will throw at 32-feet, just filling a screen six feet wide. Other distances and picture sizes are in the same proportion.

Another new accessory offered by the Bell & Howell Company is the 16 mm Filmo Titler, which will fit Filmo 141, 70, and 121 Cameras without the use of separate, loose adapters. A clever arrangement permits titles to be centered accurately through the viewfinder of each camera. This "visual centering" feature fills a long felt want, and with it, off-center titles are a thing of the past. The titler consists of a camera carriage, a title-card carriage, and two swiveled reflectors, each unit sliding upon a connecting track and clamping firmly in any position. The Filmo Titler can be used in the conventional horizontal position, or it may be set up vertically, as an animation stand, or to permit the filming of a title actually being written by a human hand. The reflectors are adjustable and are made to take ordinary No. 1 photoflood lamps. For universal focus lenses, and for those which do not focus as close as one foot, a supplementary lens in an adjustable mount is available.

Announcement of a new Filmosound Projector, moderately priced and designed especially for home use. The Filmosound DeLuxe Model is

housed in polished walnut cases which blend smoothly with the finest home furnishings. The projector unit is fundamentally the same as that of the "Academy" Filmosound. A 750-watt lamp furnishes brilliant illumination, and—very important to the home movie-maker—the new Filmosound will project the silent 16 mm. movies made at home, as well as sound films. A phonograph turntable, or record player, also in walnut cases to match the DeLuxe Filmosound, will shortly be available. With this unit plugged into the Filmosound, the records played upon it will be heard from the speaker near the screen, and when the owner's silent films are projected, he may bring to them suitable musical backgrounds with records of his own choosing. The company offers a microphone which may be plugged into the Filmosound, whereby the home movie maker may speak from the screen. His voice rides along smoothly on the background music, or alone—he becomes his own commentator, the voice of his silent films.

Owners of 16 mm. silent or sound Filmo projectors will be interested in the new 750-watt, 10-hour life, lamp just announced, which does not generate additional heat. It does not replace the standard 750 watt lamp, but is designed as an additional unit for projection of long throws where lamp life is of secondary importance.

News from E. LEITZ, Inc., New York, N.Y.:

A new printing of the "LEICA MANUAL" has just been issued, which is designated as the 1940-41 edition. The entire book has been completely revised to include the latest information on miniature camera photography and Leica equipment.

Improvements in Leica Synchronized Flash Units: The efficiency and convenience of making synchronized flash exposures with the Leica and the Model V and Model VI Leica Synchronized Flash Units have been further increased by the inclusion of a number of basic improvements, and also through the addition of a number of special accessories. The new features of the two Leica Flash Synchronizers include: an outlet on the lamp socket for joining a second flash lamp to the circuit, so that two lamps may be flashed at the same time; a dull-surfaced reflector which provides a soft, even light; a ball-springed clip which permits three positions for the reflector so that different size lamps may be properly centered, and an Automatic Release is provided with the Model VI, which permits the shutter of the camera to be released and the bulb to be flashed, always at the proper time, thereby insuring constant uniformity. A special model of the Automatic Release is available for the Model V Synchronized Flash Unit, as a separate accessory.

Eveready Filter Case: Containing two compartments, the new

Eveready Filter Case is securely attached for use to the back of the regular Leica Eveready Case—by means of buttoned flaps which snap around the shoulder strap of the camera case. Because of its ingenious design, the Eveready Filter Case adds very little to the slight bulk of the camera case, and does not interfere with the operation of the Leica contained in the latter. Filters placed in the Eveready Filter Case are removed for use by unbottoning and lifting the flap of the case. Their respective colors may be easily observed without handling their mounts or glass surfaces. Leitz filters accommodated by this case include the various screw-in filters for the 50-mm Leitz Summitar lens and the various 34 mm filters in slip-on mounts designed for the 59 mm Elmar, Hektor, and Summar lenses, the 28 mm and 135 mm Hektor, and the 35 mm and 90 mm Elmar.

News from Agfa Ansco, Binghampton, N. Y.

New Paper Surface for Cykon: Another attractive surface has just been added to the growing assortment of surfaces in which Agfa Cykon and Cykora papers are being supplied. The new surface, designated as MATTE WHITE, is neutral white in color and provides a smooth, even surface devoid of sheen or texture. Suitable for a wide variety of subject material, from pictorial views and landscapes to portraits and still life, it is available in three grades of contrast in both Cykon and Cykora emulsions.

New "Tray-Clip" Thermometer:

The new, inexpensive, Agfa "Tray-Clip" Thermometer is a darkroom accessory that every photographer who develops in trays or small, open tanks will want to have. Furnished on a stainless-steel support with a clever bend at the top, this new thermometer has been designed with the realization that to be effective and useful a thermometer must be in the developing solution, conveniently placed, but not in the way, throughout development. The new "Tray-Clip" Thermometer answers these requirements, since with its exclusive clip-on feature it can be attached snugly to one side of the tray or to one end of a small, open developing tank, where it can be quickly seen without interfering with the handling of films during development. High visibility is assured by the use of large numbers and degree marks on the scale and by prism-type construction of the glass column to magnify the width of the fluid column. The thermometer fluid is dense black in color, easily visible under all types of safelight illumination.

Fourth Contrast Grade is Announced for Agfa Cykora Paper:

Photographers who prefer a glossy projection paper with warm black tones will be interested to know that the popular Agfa Cykora

Paper is now available in four grades of contrast. The new fourth contrast grade, which is available in Cykora Glossy only, will be of especial value to news photographers, photofinishers and commercial men, as it considerably extends the range of negative suitable for this warm-tone paper.

Cameron Surgical Specialty Co., Chicago, Ill., have announced the Cameron Color-flash Clinical Camera.

A portable camera in stream-lined aluminum housing for endoscopic, orificial, superficial, portrait and general scientific photography in natural colors and black and white. With five anastigmat lens assemblies for photographing at 3, 6, 12, and 24 inches and Infinity.

Equipped with three standard dry battery cells positioned inside housing for lighting the focusing lamp used to find and illuminate the area to be photographed, and to actuate a standard photoflash bulb used to take the picture which bulb is also internally positioned for endoscopic and close-up photography. The shutter is synchronized with the photoflash bulb, and both are actuated by either trigger or standard cable release provided on side of the camera.

Makes pictures in either natural colors or black and white up to 1⅛ x 1¼ inches depending on size of area photographed. The films made can be used as transparencies for slide projection or magnified in film-viewers, and can also be printed in different sizes on paper in black and white or natural colors. Instrument is supplied complete with convenient Conical Adapter for special use in proctoscopic and sigmoidoscopic photography. Also supplied with a synchronized clamp-on reflector having 16 feet of rubber covered cord and connection for using photoflash or photo-flood bulbs in making pictures at distances over 12 inches or at infinity with external illumination.

Camera weighs only 3 pounds. Provided with a pebbled finish genuine leather carrying case 8½ x 6½
x 3½ inches.

New "Blue Brand" Eastman Ultra-Speed X-Ray Film:

Increased speed, with no sacrifice in other qualities, is offered in a new "Blue Brand" Eastman *Ultra-Speed* Safety X-Ray Film, just announced from Rochester by the Eastman Kodak Company.

Radiographs on the "Blue Brand" Ultra-Speed film can be made with only three-quarters the exposure required by the older-type Eastman *Ultra-Speed* X-ray Film. Results are the same or superior; and important properties—the contrast, ability to record fine detail, exposure latitude, tint of the base, and uniformity—are stated to be identical with those that characterized the older-type film.

ASSOCIATION NEWS

1940 Salon

ANYONE, member or non-member, who makes pictures of biologic subjects is welcome to submit entries for the annual Salon. After the Salon has been shown at the National Convention, it becomes a Traveling Exhibit, which is available for showing at scientific meetings and institutions. In this way it is seen by many people in various sections of the country. It affords a stimulus to local photographers to try out new methods and to improve the quality of their work. The only Traveling Exhibit of its kind, it shows at a glance the major trends of photography in the biological sciences. If you have entries in the Salon you are helping to illustrate the methods of a highly important form of photography in our country today. You are also giving yourself an opportunity to compare your results with those of other craftsmen on similar subjects.

The specifications for the 1940 Salon were mailed to members in the Spring Bulletin. If you are a member it may be well for you to go over the rules again as a check on preparing your entries. If you are not a member we urge you to read these specifications and we cordially invite you to avail yourself of this opportunity of exhibiting your work.

1940 Salon Specifications

All entries must be in the hands of the Salon Committee by September 5, 1940. Please send all material to Mr. Leo C. Massopust, Marquette School of Medicine, 561 N. 15th Street, Milwaukee, Wisconsin. No entries will be accepted after the closing date. Any package that must go through the customs should be plainly labeled, "Photographs for Exhibition — Not for sale — No commercial value — May be opened for postal or customs inspection." An acknowledgment of the arrival of each package will be maid by mail.

Prints. All prints must be mounted on light colored stock measuring 16 x 20 or 12 x 16 inches. When a series of prints illustrating one subject is shown, as many prints as convenient should be placed on one mount. All pictures should be precisely captioned, and type of film, camera, lens, lights, exposure time, paper, etc. should be stated. Short descriptions of technic and lighting diagrams should be given wherever a particular problem is being illustrated. The name and address of the exhibitor must appear on the back of each mount; it should also appear in a suitable manner on the face of the mount.

Transparencies for Exhibit in Viewing Boxes. Transparencies to be

shown with the Salon are welcome but they should be sent in viewing boxes if possible. If that is impossible, they should be sent well ahead of time so that viewing facilities may be arranged.

Transparencies for Projection. Lantern slides 3¼ x 4 or 2 x 2. Either size eligible but must be mounted ready for projection. No film strips. Each plate must carry the name of the exhibitor as well as a marker indicating the correct position for placing in the projector. All the accepted entries will be shown at a special projection session.

The Salon Committee reserves the right to reproduce any of the exhibits in our Journal and to give permission for the publication elsewhere of individual views of the Salon. Reasonable care will be taken of all entries submitted but the Committee will not be responsible for damage or loss.

The prints selected and hung will be assembled as the Annual Traveling Salon, which will be exhibited in many places in the United States. With the exception of prints in color and transparencies, all of this material will be assumed to be the property of the Association for one year after which time they will be returned to the exhibitor on request. Each print so exhibited will have placed on the back a suitable label showing that it was accepted by the jury. The Committee would appreciate the donation of color prints and transparencies under the same conditions, but they do not insist upon this.

1940 Print and Slide Competition

The photomicrographic competition displayed at the 1939 Convention aroused enough interest to warrant another contest. This time the test will concern only one subject, an X-ray film which all contestants must copy and print on both paper and lantern slide. The few rules are as follows:

1 copy to be submitted on glossy paper 5″ x 7″.

1 3¼″ x 4″ lantern slide to be made from the same negative used to make the print.

Print to be mounted on an 8″ x 10″ mount, on which name of photographer, name of his institution and type of film used to make the intermediate should also appear.

The X-ray film may be obtained by writing to Mr. William Payne, State Institute for the Study of Malignant Disease, 113 High Street, Buffalo, New York, who is in charge of the competition; or by writing the Association's Secretary, Miss Anne Shiras, University Office, Magee Hospital, Pittsburgh, Pennsylvania. X-rays are among the most difficult of all copy material. Send for the film and compare your results with others from the same subject.

CHAPTERS OF THE B.P.A.

The youngest member among the local Chapters is the present version of the Chicago Chapter, organized last January. The Secretary Mr. John A. Maurer of the Loyola University School of Medicine writes: "All programs so far given here have been topnotch affairs of the very type and quality you would like to find in such an organization. I have been in quite a little camera club work and am more than pleased personally at the quality of the programs that have been presented thus far." The programs have included a diversity of subjects including a demonstration of a One Shot Color Camera; discussion of the spectral distribution of lights, films, filters; discussions of photomicrography, macrography, and mycology; line and half-tone copy work, etc. Anyone interested may join as an Associate; Active Membership has as one of its requirements, membership in the National B.P.A.. The Chapter dues are $3.00 a year. Mr. William Martinsen of the Municipal Tuberculosis Sanatorium is Chairman and was active in the formation of the group. We shall look forward to meeting the members of this new Chapter in Milwaukee next September.

The Pittsburgh Chapter held its last meeting of the season in May and looks forward to starting its four year next fall. Mr. Chester Henry of the Falk Clinic continues as Chairman. The next-to-last meeting consisted of a trip through a lithographing establishment which was most interesting and is heartily recommended to other Chapters. We do not know how many of the members can make the trip to Milwaukee but we know the Chapter will be represented there.

Just as the above was put in the mail-box a letter came from Mr. R. G. Burton, Secretary of the Philadelphia Chapter. He gave a summary of the activities of this chapter, saying they were based on following up chronological information on various phases of the members' work. Color photography and its lighting, the effect of polarized light, intra-oral photography, negative and printing control, lantern slide technics are subjects that are kept currently running. In discussing their meetings in general he states that "present reactions of our meetings lead us to believe that there is a definite need for the stabilization of prices, uniformity in the methods of delivery of photographs and transparencies, and that some arrangements be made necessarily to increase the potential knowledge of men and women doing biological photography, and in instances where achievement has been made in this field, that suitable notations of merit be accorded these men and women."

Mr. Burton adds: "As a special project at the present time, not yet completed, we are endeavoring to acquaint the various hospitals in and around the city of Philadelphia that the Biological Photographic Association has capable men and women who can photograph various phases of biological work. In this respect, we have started to make up a series of display panels which are being placed in various hospitals, showing different phases of biological photography. These are made so that they can be rotated monthly, thereby keeping a constant series of new subjects.

"In the near future we plan to have our annual banquet and get-together, at which photography will not be discussed."

Just as the Journal was going to press, the Boston Chapter was heard from. From all accounts, their membership is very active, and real news will come from this chapter in the next issue.

SUSTAINING MEMBERS

The following are the Sustaining Members who help to finance the activities of your association:

Mr. John F. Brooks
E. Leitz Company
New York City

The Fleischmann Laboratories
New York City

Mr. Louis Paul Flory
Boyce Thompson Institute
for Plant Research
Yonkers, New York

Mr. Leonard Perskie
Defender Photo-Supply Co.
142 West 24th Street
New York City

Mr. Louis Schmidt
Rockefeller Institute
New York City

Dr. George H. Semken
16 West 85th Street
New York City

Miss Anne Shiras
University of Pittsburgh
Pittsburgh, Pennsylvania

Hr. H. W. Zieler
E. Leitz Company
New York City

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LEO C. MASSOPUST, Editor
Marquette University, School of Medicine
Milwaukee, Wisconsin

ASSOCIATE EDITORS

ANNE SERRAO
School of Medicine
University of Pittsburgh, Pa.

ARTHUR W. PROETZ, M.D.
Rauscher Building
St. Louis, Mo.

FERDINAND HARDING
The Children's Hospital
Boston, Mass.

ARTHUR W. FUCHS
343 State St.
Rochester, N. Y.

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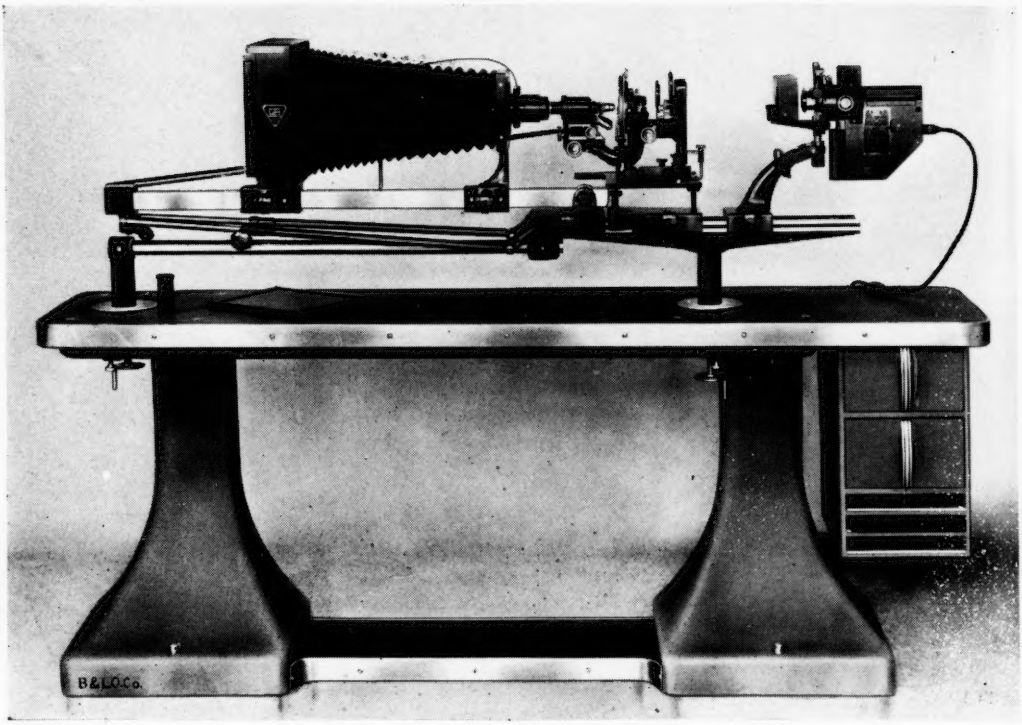

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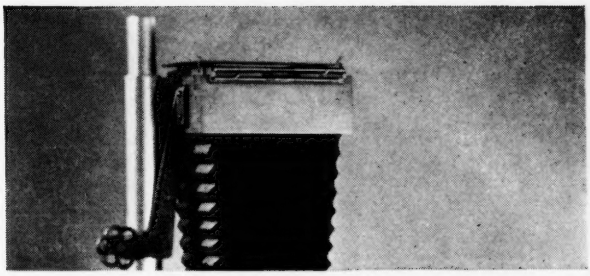

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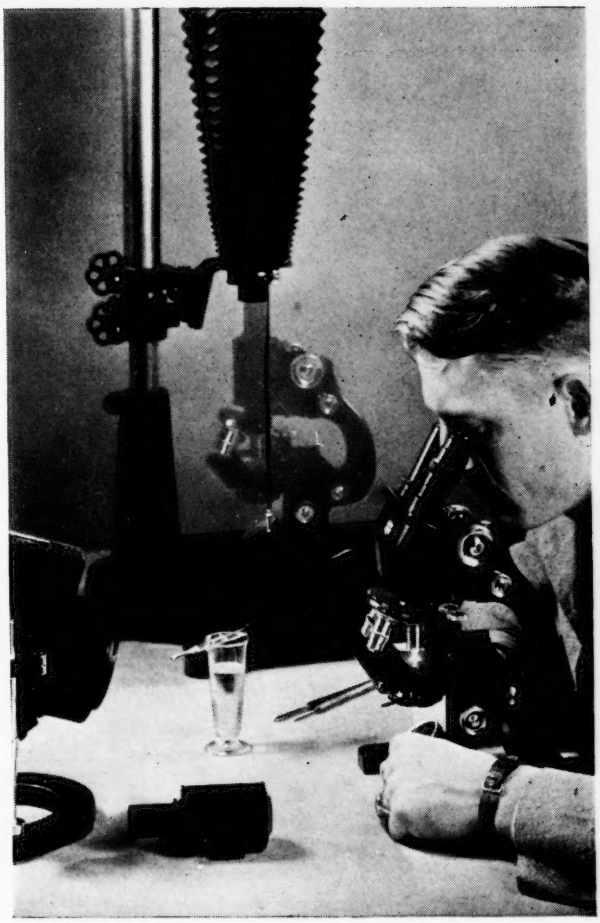

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